

# Dental skill competitions: A strategy to improve the comprehensive learning competency of dental students measured by their self-rating

**Kangqi Zhu**

School of Stomatology, Zhejiang Chinese Medical University

**Jiaying Feng**

School of Stomatology, Zhejiang Chinese Medical University

**Pei Zheng** (✉ [20161040@zcmu.edu.cn](mailto:20161040@zcmu.edu.cn))

School of Stomatology, Zhejiang Chinese Medical University

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## Research Article

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# Abstract

## Objectives

Due to the limitation of access to clinical experience and the difficulty of promoting teaching methods, improving the comprehensive learning competency of dental students has become increasingly challenging. In this study, we evaluate the effect of dental skill competitions on students' comprehensive competency.

## Methods

Ninety fourth-year dental students at XXX University were recruited for this study: 26 students for 2016-17, 34 students for 2017-18 and 30 students for 2018-19. Students who volunteered to participate in competitions (participation group, PG) and students who did not participate in competitions (control group, CG) were asked to rate themselves, using questionnaires, on a comprehensive competency scale (including critical thinking, professional practice competency, professional theory competency, and learning motivation). There were 45 students in each group. Students were also asked to rank their mastery of the four competencies. The students' final scores on theoretical and practical courses were also considered as reference items.

## Results

A total of ninety responses were obtained (100% response rate). The PG was statistically significantly higher than the CG in critical thinking ( $p = 0.037$ ), professional practical competency ( $p < 0.01$ ), and learning motivation ( $p = 0.03$ ). Their final theoretical and practical scores are consistent with the statistical results of the questionnaires. In the ranking of students' competency, at the beginning of the term, CG had the least proficiency in professional theoretical competency and PG, in critical thinking and professional practical competency. At the end of the term, learning enthusiasm, and critical thinking (for CG), professional theoretical competency (for PG) were at the bottom of the list.

## Conclusions

Dental skill competitions can effectively improve students' critical thinking and professional operation competency and maintain students' enthusiasm for learning. The evaluation method adopted in this study also provides an indicator of teaching evaluation.

## 1. Introduction

As a clinical subject, dentistry requires strong practicality and operability.<sup>1</sup> Dental students should aim to improve their comprehensive competency, including critical thinking, professional theory competency,

professional practice competency, and learning enthusiasm.<sup>2</sup> The fall in teaching staff and insufficient numbers of suitable patients contributes to a reported reduction in clinical experience for students.<sup>3</sup> Additionally, the increasing number of students and the decrease of financial support exacerbate the situation of insufficient comprehensive competency acquisition of students.<sup>4-10</sup> The conditions are unfavorable for improving the comprehensive competency of dental students.

Rapid Prototyping (RP) models with 3D virtual models were supposed to help students to develop proper visual recognition skills and rapid model prototyping of different cavity preparations. However, only a few studies have addressed it as a teaching resource.<sup>11,12</sup> The application of computer simulation and virtual reality technology in dental education provides several advantages over conventional training using manikins. These advantages include self-paced training, individualized assessment, frequent and continuous feedback from the computer, and image viewing of the exercise from multiple angles. Computer simulation (CS) for teaching skills can be beneficial because it is integrated with current conventional training curricula. However, the use of virtual reality (VR) in dental simulation is still debatable, with inconclusive evidence for its long-term effects.<sup>13,14</sup> These methods have been proven to improve students' operational competency. However, they may be difficult to implement widely because of cost and usability.

Dental clinical training on the tooth or dental head model systems, such as cavity preparation, dental remodeling, and root canal treatment, is still the main method for cultivating the clinical practice skills of dental students in dental colleges. In general teaching programs, dental students need more than one year of the model practice training. However, it may be difficult to maintain enthusiasm during long-term operation practice.

Dental operation skill competitions have been conducted in some Chinese dental colleges, which may promote dental students' enthusiasm for training and improve clinical practice competency and professional operation skills. The competitions, mainly for third- and fourth-year students, always include cavity and crown preparation, tooth carving, and other essential dental skills.

Five years ago, students of XXX University participated in college-level and inter-university competitions. In this study, we evaluate the impact of dental operation skills competitions on students' comprehensive ability through the analysis of student self-ranking and course scores.

## **2. Materials And Methods**

### **2.1 Participants**

Dental skill operation competitions in XXX University, were conducted for third- and fourth-year students. Each year had a total of 100–110 students. Students could voluntarily sign up for pre-competition training and competitions. The contents of the competition included tooth carving, class II cavity

preparation, incisor crown preparation, periodontal exploration, and surgical sutures. These practices were performed on the dental head mold systems.

The 12-week pre-competition training (3–5 times per week) was guided by several teachers from different professions. Preoperative preparation, a competition content overview, and a step-by-step outline were taught to enrolled students.

This study was approved by the Institutional Review Board of XXX University (protocol #XXX). The study was administered to ninety fourth-year students in academic years 2016-17, 2017-18 and 2018-19 and divided into two groups. Their average scores in dental-related courses in third-year—including oral anatomy and physiology, oral histopathology, oral medicine, and pediatric dentistry—were between 80 and 90 out of 100.

According to the criteria, the participation group (PG) included 45 students voluntarily participating in dental operation skill training and competitions. The other 45 students, who were not enrolled in the competitions, were matched in the control group (CG). There was no statistically significant difference in the average age and gender composition of the students between the two groups (Table 1).

Table 1  
Basic information of research subjects

| group               | sex                     | average age | number | average score |
|---------------------|-------------------------|-------------|--------|---------------|
| participation group | 22 males and 23 females | 24.53       | 45     | 82.71         |
| control group       | 21 males and 24 females | 24.49       | 45     | 82.38         |

**Table legend:** The basic information of the students participating in this study is shown in this table. Ninety fourth-year dental students at XXX University were recruited for this study: 26 students for 2016-17, 34 students for 2017-18 and 30 students for 2018-19. Their average scores in dental-related courses in third-year were close to the same. The participation group (PG) included 45 students voluntarily participating in dental operation skill training and competitions. The other 45 students, who were not enrolled in the competitions, were matched in the control group (CG). There was no statistically significant difference in the average age and gender composition of the students between the two groups.

## 2.2 Methods

The retrospective post-test study consisted of two parts: students' self-evaluation (Part I) and performance comparison (Part II).

### 2.2.1 Part I: Students' self-evaluation

A questionnaire survey was administered to the participants (Table 2). Students were asked to rate themselves on each of the four competencies (critical thinking, professional theoretical competency, professional practical competency, and learning enthusiasm) after they had completed the four-year

course. The PG students completed the competitions simultaneously. Each competency was divided into several questions, the answers of which were rated on a five-point scale (1 = not competent at all, 2 = below competent, 3 = not sure, 4 = competent, and 5 = very competent). The survey results are shown in Table 3.

Based on their answers to these questions, students were also asked to rank their mastery of the four competencies.

Table 2  
Questionnaire about student's comprehensive competency

|                                     |   |
|-------------------------------------|---|
| Critical thinking                   | Q1. You can aware of your difficulties and obstacles in the process of learning at this stage.                                  |
|                                     | Q2. You can think about solutions to these difficulties and obstacles.  |
|                                     | Q3. You can think carefully about the pros and cons of these solutions.   |
|                                     | Q4. You can listen to other points of view, consult the literature for help and think of solutions.                             |
|                                     | Q5. When you encounter a strange idea, you will not resist it.  |
| Professional theoretical competency | Q1. You have a good knowledge of dental anatomy.  |
|                                     | Q2. You have a good knowledge of cavity preparation.  |
|                                     | Q3. You have a good knowledge of full crown preparation.  |
|                                     | Q4. You have a good command of making full dentures   |
|                                     | Q5. You have a good understanding of the principles of dental aesthetics.   |
| Professional practical competency   | Q1. You have a good understanding of humane care.   |
|                                     | Q2. You have a good understanding of the principles of infection prevention and control in clinical practice.                   |
|                                     | Q3. You have a good command of dental clinical operation.   |
|                                     | Q4. You can properly use dental equipment.  |
|                                     | Q5. You can understand properly practical abilities related to cavity preparation, full crown preparation and complete denture. |
| Learning enthusiasm                 | Q1. You take the initiative to learn professional knowledge in your spare time.   |
|                                     | Q2. You find other resources outside the textbook for extended learning   |
|                                     | Q3. The extra time spent in the competition does not affect your study (the control group did not answer).                      |
|                                     | Q4. Participating in skill competition improve your learning enthusiasm (the control group did not answer).                     |

## Table legend

The questionnaire provided to the students is shown in this table. Students were asked to rate themselves on each of the four competencies (critical thinking, professional theoretical competency, professional practical competency, and learning enthusiasm) after they had completed the four-year course. Each competency was divided into several questions, the answers of which were rated on a five-point scale (1 = not competent at all, 2 = below competent, 3 = not sure, 4 = competent, and 5 = very competent).

## 2.2.2 Part II: Performance comparison

With the consent of the students, the average scores of the final theory and practice scores of four courses, including prosthodontics, cariology and endodontics, oral and maxillofacial surgery, and periodontics, were used as the data for comparison.

## 2.2.3 Statistics

All statistical analysis was conducted using SPSS25.0. The mean scores for each item of the four competency ratings were then computed. The score for each competency domain was computed by dividing the summed score for each domain by the number of survey items for that domain. The mean score for each domain was computed as the mean of the domain scores for all respondents.

On completing these questions, students were required to rank their mastery of these four competencies. The results of the rankings are summarized in terms of the proportions of the first and last positions. The students' final exam scores were averaged for the auxiliary evaluation. The average value of the students' final theoretical and practical test scores was calculated. A paired t-test was used to examine significant differences in student ratings. A significance level of 0.05, was set for the analysis.

## 3. Results

### 3.1 Students' self-rating

The results of the questionnaires are presented in Table 3. A total of 90 responses were obtained (100% response rate). The rating in the domain of professional practical competency was significantly different between the two groups, with students in the PG showing higher scores ( $p < 0.01$ ). There were also significant differences in the rating for the field of critical thinking and learning enthusiasm, with lower scores for students in the CG ( $p < 0.05$ ). There were no significant differences in professional theoretical competency.

| <b>Table 3. Students' self-evaluation about four domains of their comprehensive competency—mean rating (standard deviation) and comparison</b> |                     |               |                 |
|--|---------------------|---------------|-----------------|
| Competency   | participation group | control group | <i>p</i> -value |
| critical thinking  | 3.69±0.75           | 3.55±0.64     | 0.037*          |
| Professional theoretical competency  | 3.50±0.78           | 3.43±0.98     | 0.34            |
| Professional practical competency  | 3.65±0.72           | 3.11±0.65     | 0.01*           |
| learning enthusiasm  | 3.56±0.73           | 3.36±0.74     | 0.03*           |

\* indicates statistical a significant difference ( $p \leq 0.05$ )

**Table legend** The results of the questionnaire is shown in this table. The ratings in the domain of professional practical competency, critical thinking and learning enthusiasm were significantly different between the two groups, with lower scores for students in the CG ( $p < 0.05$ ). There were no significant differences in professional theoretical competency.

## 3.2 Competency rank

At the beginning of the semester, 44.4% of the students in PG thought that their learning enthusiasm was the best, followed by professional theoretical ability (24.4%). Further, 36% of the students had the least proficiency in critical thinking, the same as professional practical competency. At the end of the semester, 42.2% of the students in PG believed that their learning enthusiasm was the best, followed by critical thinking (33.3%), while 57.8% of students thought they had the least mastery in the domain of professional theoretical competency.

In contrast, at the beginning of the semester, professional theoretical competency (44.4%) ranked high for students in the CG. Professional practical competency (33.3%) was at the bottom. At the end of the semester, There was no consensus among the students, and the proportions of all four competencies were close (17.8%, 26.7%, 28.9% and 26.7%). (Figs. 1.1 and 1.2).

## 3.3 Scores for the courses

There was no significant difference between the two groups in the horizontal comparison of the theoretical scores in the four courses. The final operation scores of the students in the PG were significantly higher than those in the CG (Table 4).

| <b>Table 4. Student s' final grades of their four main courses—mean rating (standard deviation) and comparison</b> |                     |               |                 |                     |               |                 |
|--|---------------------|---------------|-----------------|---------------------|---------------|-----------------|
|  | theory              |               |                 | practice            |               |                 |
| subject  | participation group | control group | <i>p</i> -value | participation group | control group | <i>p</i> -value |
| Prosthodontics   | 83.64±3.83          | 82.18±3.95    | 0.077           | 84.11±8.55          | 79.78±8.32    | 0.017*          |
| Cariology and Endodontics  | 83.24±3.99          | 82.73±4.00    | 0.545           | 83.33±7.39          | 79.67±7.86    | 0.025*          |
| Oral-and-maxillofacial surgery   | 82.87±4.15          | 82.58±4.36    | 0.748           | 82.89±8.63          | 79.67±5.78    | 0.040*          |
| periodontics   | 82.64±3.50          | 82.71±4.21    | 0.935           | 81.89±7.33          | 78.67±6.69    | 0.032*          |

\* indicates a statistical significant difference (P<0.05)

**Table legend:** The average scores of the final theory and practice scores of four courses (prosthodontics, cariology and endodontics, oral and maxillofacial surgery, and periodontics) were used as the data for comparison. There was significant differences between the two groups in the horizontal comparison of the practical scores in the four courses, with lower scores for students in the CG. There was no significant difference between the two groups in the horizontal comparison of the theoretical scores.

## 4. Discussion

Numerous studies have shown that students' self-evaluation is very important in the teaching process.<sup>15-18</sup> In this study, we used students' self-rankings and scores to evaluate the influence of the dental skills competition on students' comprehensive competency.

In the students' self-ratings for the four domains of their comprehensive competency, the PG was significantly higher than the CG in critical thinking, professional practice competency, and learning enthusiasm. However, the difference in the ratings of professional theoretical knowledge between the two groups was not significant. The reason might be that the dental operation skill competition did not test all the professional learning of the students. Theoretical knowledge, operation skill training, and clinical training are all very important for dental education. The final theoretical and practical scores were consistent with the above statistical results.

At the beginning of the fourth year, about half of the PG students ranked last their mastery of critical thinking competency, followed by professional practice competency. Most of the students in the CG as well, ranked these two items last in terms of mastery. Professional practice competency is the domain in

which students had the least experience because the courses in this field began in the fourth grade at the university, and critical thinking was lacking for students.<sup>19</sup> It is worth mentioning that at the beginning of the semester, 44.4% of the PG students ranked their learning enthusiasm first, compared with 20% in the CG. This showed that the learning enthusiasm of the PG at the beginning of the semester was much higher than that of the CG, which may explain why they voluntarily signed up for the skill competition.

Through the self-evaluation of students' final operation performance and practical competency, it was evident that the PG was significantly better than the CG. This may be related to curriculum design. Practice courses are generally arranged 1–2 times a week, and students rarely have the opportunity to use the equipment for operation practice after class. Limited practical curriculum arrangements and the lack of a practical atmosphere are unfavorable for the improvement of students' practical competency. In contrast, students' participation in the dental skills competition offers more practical opportunities, and they learn and practice in a more positive and diligent atmosphere.

In the domain of critical thinking and learning enthusiasm, the ratings of the PG were significantly higher than those of the CG. First, the PG students spent more time studying related aspects to obtain good results in the competition, which indirectly improved their learning habits. Moreover, the dental operation skill competition enhanced the students' ability to transfer knowledge to a live performance. Second, the evaluation machines used in the competition, with real-time feedback, allowed students to identify their mistakes in real-time. Tutors could also single out students in practice. This effectively promoted students' self-evaluation and reflection. Competitions always set up rankings, and the best operator is given the highest reward. The trend in recent years has been to move away from ranking or competition as a learning strategy and reward all participating students. However, the different characteristics of students' practice results should be pointed out, summarized, and praised. The encouraging role of competition for students' learning may be used for maximum benefit.

Skills competitions, which provide a platform for students to practice and operate, do not require additional investments in equipment or the training of specialized personnel. Along with being a low-cost teaching promotion method, it also has satisfactory teaching results. Further, for the newly established stomatology school, competitions are conducive to the rapid accumulation of teaching experience. This may also be suitable for worldwide implementation.

A limitation of this study is that since students rated their competency levels before and after the competition only after participating in the competition, their pre-competition ratings were based on memory, which may be flawed and/or affected by their post-competition perceptions. In addition, the study may have limited generalizability because it was conducted at only one dental school. Additionally, since most of these students do not have formal jobs in hospitals, we will continue to watch the long-term impact of the competition. Despite these limitations, this study demonstrates the value of dental skill competitions in improving students' comprehensive ability from their perspective.

The results of this study suggest that dental operation skill competitions should be vigorously promoted in dental colleges. Competitions should be developed for students of all years.

## **5. Conclusion**

Participating in dental operation skill competitions can improve students' learning enthusiasm and cultivate critical thinking. Students will also gain more professional knowledge and undergo practical operation training during their spare time. In general, the dental skill competition has effectively improved students' comprehensive competencies. The low cost and satisfactory teaching results show that it is an effective method for students to improve their practical skills in today's medical environment and should be popularized. The evaluation method used in this study can also be used to provide feedback on the impact of teaching methods on students.

## **Declarations**

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### **Author information**

#### Affiliations

School of Stomatology, Zhejiang Chinese Medical University. 548# Binwen Road, Hangzhou 310053, China

Pei Zheng, Kangqi Zhu & Jianying Feng

### **Contributions**

All authors contributed to the conception or design of the work, the acquisition, analysis, or interpretation of the data. Kangqi Zhu and Pei Zheng wrote the main manuscript text, Jianying Feng was the principal investigator for this study and conducted an online survey. All authors read and approved the final manuscript.

### **Corresponding author**

Correspondence to Pei Zheng

## Ethics declarations

Ethics approval and consent to participate

This study was approved by the Institutional Review Board of the School of Stomatology, Zhejiang Chinese Medical University (protocol #2019-05). The research methods used in this study adhere to the Declaration of Helsinki. Completion of the survey and interviews served as informed consent. All participants were at least 18 years of age.

## Consent for publication

No individual person's data in any form (including any individual details, images, or videos) was used in this project of manuscript, therefore consent is not applicable.

## Competing Interests

None.

## Availability of data and materials

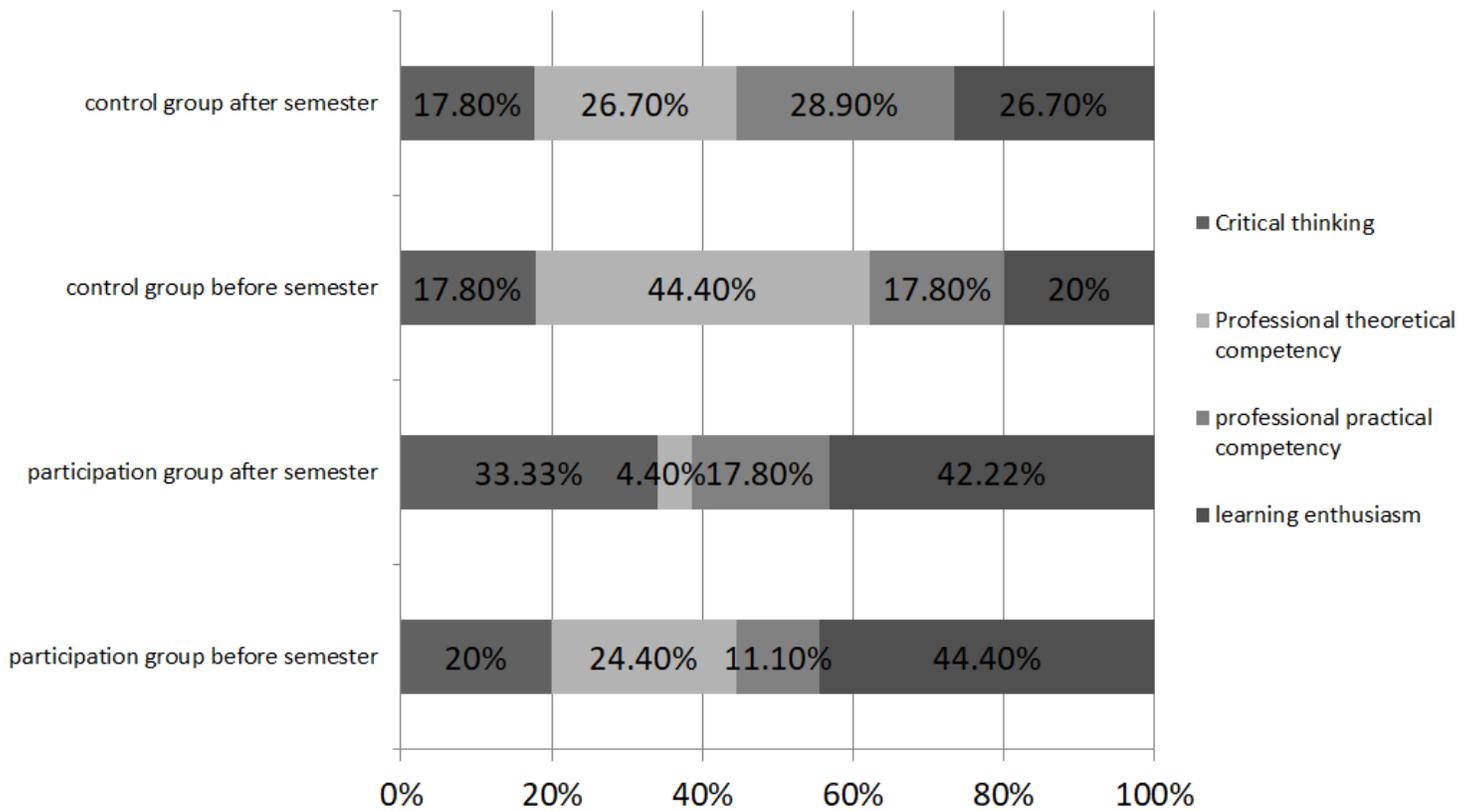
The datasets generated during and analyzed during the current study are not publicly available as participants were assured that their individual responses would not be disclosed. However, de-identified, consolidated data are available from the corresponding author upon reasonable request.

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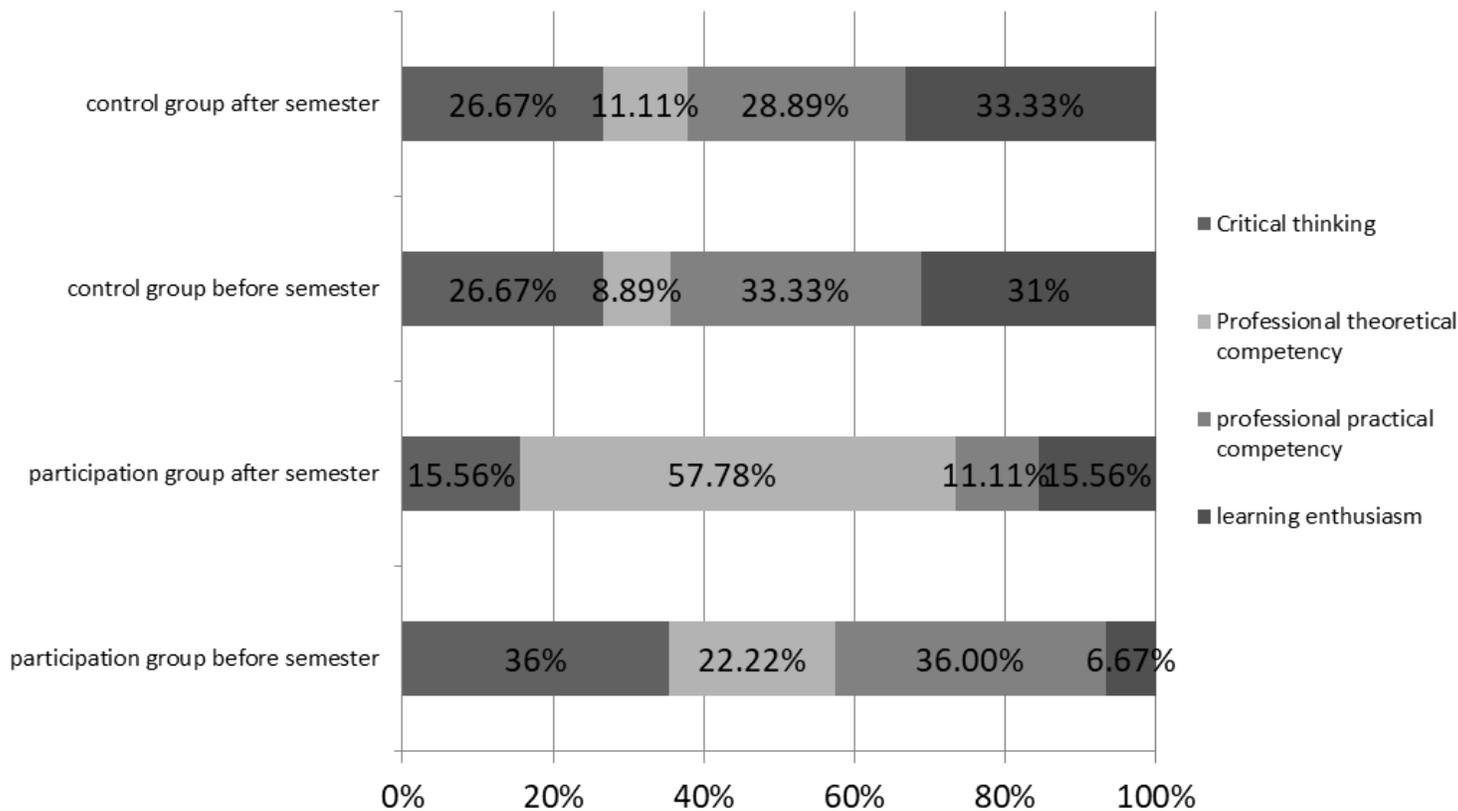
## Figures



**Figure 1**

Students self-evaluation about four domains of their comprehensive competency: Competency mastery ranking(percentage)-top

**Figure Legend:** Students who volunteered to participate in competitions (participation group, PG) and students who did not participate in competitions (control group, CG) were asked to rank their mastery of the four competencies (critical thinking, professional theoretical competency, professional practical competency, and learning enthusiasm) before and after they completing the fourth year course. We counted the top/bottom compency of the students respectively and presented them in the form of percentages on the figure.



**Figure 2**

Students self-evaluation about four domains of their comprehensive competency: Competency mastery ranking(percentage)-bottom

**Figure Legend:** Students who volunteered to participate in competitions (participation group, PG) and students who did not participate in competitions (control group, CG) were asked to rank their mastery of the four competencies (critical thinking, professional theoretical competency, professional practical competency, and learning enthusiasm) before and after they completing the fourth year course. We counted the top/bottom competency of the students respectively and presented them in the form of percentages on the figure.