Research on the application of collaborative learning in the practice teaching of garment 3D virtual fitting

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ABSTRACT – REZUMAT

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With the integration of information science into the fashion field, both industry and university expect more informatics technology to be utilized in the fashion-related course and teaching of practical exercises. Among this informatics technology, virtual simulation, as an important experiment tool, has become very popular support for fashion students since it is possible to validate design ideas very efficiently and fast. However, because virtual simulation is quite technical, and it is very difficult to gain all the essential skills about the operation of the virtual simulation software within a short time, in the process of virtual simulation exercises, students largely rely on the guidance of teachers, which leads to the negative impact on students' learning motivation. To optimize the application of virtual simulation in the fashion-related course and teaching of practical exercises, this paper proposes a teaching method based on collaborative learning for fashion virtual simulation exercise teaching. 3D virtual fitting exercises realized by virtual simulation were adopted as the research object to verify its effectiveness. Two groups of students were involved in the experiments. One group was taught traditionally while another group was taught by the proposed collaborative learning. Through a set of learning and teaching process evaluation, experiment results demonstrated that collaborative learning will be beneficial to improving students' learning interest, efficiency, quality and facilitate the comprehensive capacity of autonomous learning, communication and cooperation, reduce the individual distinction and enhance self-confidence. This paper provides support for the future application of collaborative learning in other fashion related virtual simulation courses and exercises.

Keywords: *collaborative learning, virtual simulation, virtual fitting, exercise teaching, control experiment*

Cercetări privind aplicarea învățării colaborative în predarea practică a probării virtuale 3D a articolelor de îmbrăcăminte

Odată cu integrarea științei informației în domeniul modei, atât industria, cât și mediul universitar necesită ca tehnologia informatică să fie utilizată frecvent în cursurile de design și în predarea exercițiilor practice. În cadrul tehnologiei informației, simularea virtuală, ca instrument de experimentare important, a devenit un suport foarte popular pentru studenții de la facultățile de design, deoarece validează ideile estetice foarte eficient și rapid. Cu toate acestea simularea virtuală este destul de tehnică și este foarte dificil pentru studenți să dobândească toate abilitățile esențiale despre funcționarea software-ului într-un timp scurt, bazându-se în mare parte pe îndrumarea profesorilor, ceea ce duce la impactul negativ asupra motivației de învățare a studenților. Pentru a optimiza aplicarea simulării virtuale în cursul de design și predarea exercițiilor practice, această lucrare propune o metodă bazată pe învățarea colaborativă pentru predarea exercițiilor de simulare virtuală în domeniul modei. Pentru a verifica eficacitatea acesteia, au fost adoptate ca obiect de cercetare exerciții de probare virtuală 3D realizate prin simulare virtuală. Două grupuri de studenți au fost implicate în experimente. Un grup a fost supus predării în mod tradițional, în timp ce un alt grup a fost supus predării prin învățarea colaborativă propusă. Printr-un set de evaluare a procesului de învățare și predare, rezultatele experimentului au demonstrat că învățarea colaborativă va fi benefică pentru îmbunătățirea interesului acordat învățării, eficienței și calității și pentru a facilita capacitatea completă de învățare autonomă, comunicarea și cooperarea, reducerea distincției individuale și sporirea încrederii în sine. Această lucrare oferă suport pentru aplicarea viitoare a învățării colaborative în alte cursuri și exerciții de simulare virtuală legate de modă.

Cuvinte-cheie*: învăţare colaborativă, simulare virtuală, probare virtuală, predare cu exerciţii, experiment de control*

INTRODUCTION

In recent years, with the rapid development of information science, virtual simulation technology has been broadly applied to many disciplines with its intuitive and repeatable characteristics [1]. Virtual design systems realized by virtual simulation technology usually simulate the real systems; including human's realistic feeling in the visual, auditory, olfactory and tactile aspects in real life [2]. The virtual simulation was initially used in the design of aerospace, and now it is functionalized with a series of new technologies such as animation simulation, visual interactive simulation, virtual reality simulation, etc. Due to these advantages, it has been widely employed in the education field, such as the teaching of practice in biology, physics, geography, medicine and other disciplines. Virtual simulation exercise teaching is an

important way for students to grasp related knowledge [4]. Compared with traditional teaching methods, it has the following advantages: reducing exercise costs and waste of experimental materials, having no specific requirements for the experiment environment, being convenient to control operational details and facilitating repeated operation, and rectifying experimental scheme [5].

In the field of textile and garment related teaching, virtual simulation is also widely employed, especially in practical exercise teaching. Existing garment virtual simulation exercises include virtual garment pattern generation, virtual anthropometry, virtual fitting, virtual brand operation and virtual garment production management [6]. For example, virtual garment fitting is realized by a set of technology in different disciplines, such as computer science, material science, fashion design and garment pattern design [7]. Hong et al. employed a virtual 3D-to-2D design method to simulate a garment block and then extend the garment block, obtaining personalized ready-to-wear garment products aimed at consumers with atypical morphology [8]. They also proposed a new collaborative design-based method for designing customized garments, aimed at the physically disabled people with scoliosis, which is relied on the abstraction of feature points from a complete digitalized 3D human model realized from the 3D human body scanning date [9]. A basic garment block wireframe aligned with body features is then established based on the defined feature points of the human body. Based on the deformed wireframe, a 3D expandable garment block is modelled [10].

However, virtual simulation also has some drawbacks in the exercise teaching process. A virtual simulation exercise is generally operated based on a set of virtual models provided by virtual simulation software (such as Lectra, Clo3D). But due to technical reasons, existing simulation software cannot simulate the objects in the real world without deviations. These deviations between the simulation effect and the real garment will lead to the misunderstanding of students in the learning procedure [11]. Moreover, students are beginners in the fashion field. They lack professional fashion knowledge (such as pattern making, fitting) and are not familiar with virtual simulation software operation. Subsequently, it is difficult for students to master fashion-related virtual simulation in a short time. Therefore, students are largely relying on teachers in their learning process. They tend to follow the instructions offered by the teachers for every single step which will lead to the fact that students passively accept knowledge.

To solve this problem, the concept of collaborative learning seems to be a good solution. The concept of collaborative learning was raised by Lanster and Bell in 1700, which mainly refers to the learning mode in which the learning group is the basic unit in the teaching process, and teachers guide them to realize the cooperation between teachers and students, students and students, teachers and teachers to complete the learning tasks together [12, 13].

Collaborative learning has proven to have the following advantages: improving individual learning motivation and enhancing students' sense of responsibility, changing the situation that students passively accept knowledge and thoroughly stimulating students' subjective initiative, exercising students' social skills and improving students' comprehensive ability [14]. At present, the research on the application of collaborative learning in virtual simulation exercise teaching is limited.

In this study, we propose to integrate the concept of collaborative learning into the teaching of fashion simulation practice in order to improve teaching efficiency. Virtual fitting is a typical case of the virtual simulation exercise. This paper takes virtual fitting as the research object to verify whether collaborative learning is suitable for virtual simulation exercise teaching. By comparing the teaching effects of traditional teaching mode and applying collaborative learning mode in virtual fitting experiment teaching, this paper analyses the advantages and disadvantages of the two teaching modes and puts forward guidance for subsequent teaching practice.

METHODOLOGY

Research framework

This research is carried out in order to explore whether or not the collaborative learning methods will be suitable for virtual fitting exercise teaching and make up for the defects of traditional teaching methods. The research framework of this study is shown in figure 1. A total amount of 120 students majoring in Fashion Design and Engineering from the College of Textile and Apparel Engineering, Soochow University in 2017 (60 students) and 2018 (60 students) were selected as the experimental samples. Grade 2017 was taken as the control group and Grade 2018 was taken as the experimental group respectively. The first experiment (*Experiment I*) was carried out from September 26th to September 30th, 2018. In *Experiment I*, the traditional teaching methods was employed to teach the 2017 Grade. These students were aged (20.5 ± 1.8 years) and 6 of them are males the rest 54 students are females.

The second experiment (*Experiment II*) was carried out from September 26th to September 30th, 2019. In *Experiment II*, collaborative learning methods were employed to teach the students of the 2018 Grade. These students were aged (20.3 ± 2.1) and 9 of them are males and the rest 51 students are females. The instructors, teaching contents and teaching materials of the students in the two groups were the same, and there was no significant difference in statistics when comparing the scores of college entrance examination between the two groups ($P > 0.05$).

Therefore, the two experiments take teaching methods as the independent variable, remaining other factors identical, to compare the differences of learning effect between traditional teaching methods and collaborative learning methods employed in virtual fitting

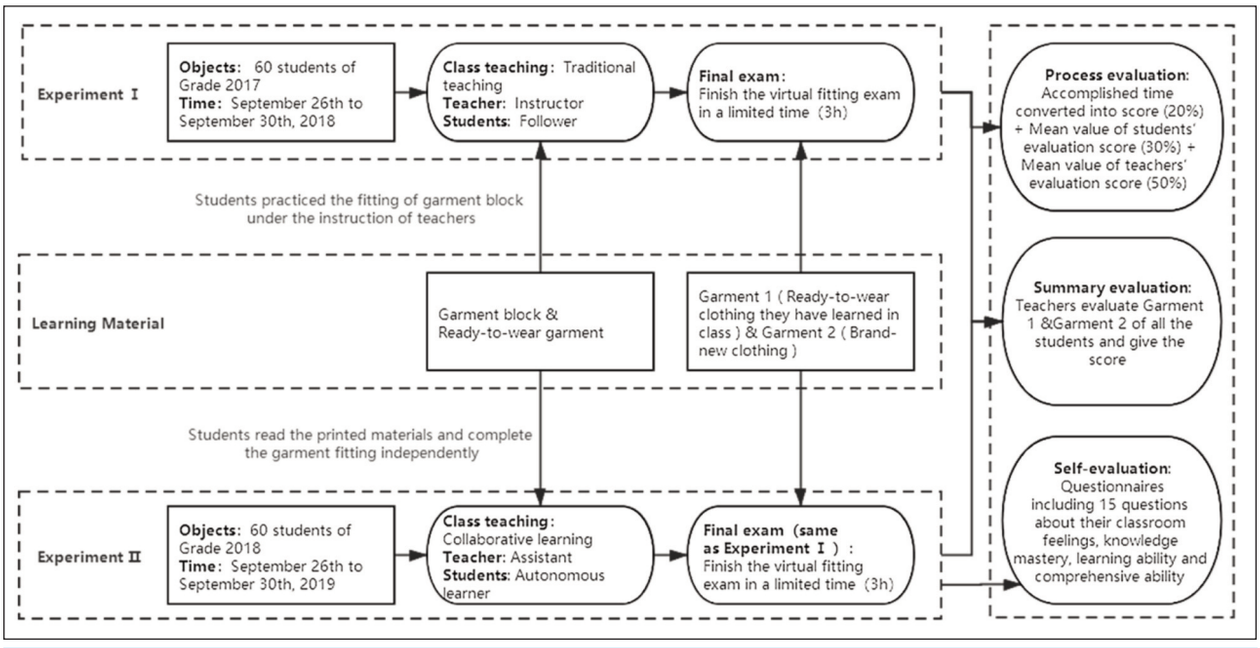

Fig. 1. Framework of research

exercise teaching. There are three evaluation procedures involved in the two experiments, which consists of two common evaluations (process evaluation and summary evaluation) and a particular self-evaluation for students in *Experiment II*. The first evaluation is performed during the learning process and the second evaluation is performed 1 month after the first evaluation. The first evaluation is designed in order to assess the learning effect including completion speed and quality of their works in the class. The second evaluation is designed to assess the maintenance of the learning effect after a period of time. The relationship between the two evaluations is the former evaluating short-term learning effects and the latter evaluating long-term learning effects respectively. The third evaluation is to investigate students' perceptions in relation to their study experience during collaborative learning.

Learning materials

The experiment subject of the two experiments (*Experiment I* and *Experiment II*) is 3D virtual garment fitting. 3D virtual garment fitting allows the simulation of all actual production sections of the fashion industry, such as stitching, fitting and visualization of textile materials on the garment [15]. The purposes of the experiment are to enable students to master the 3D virtual fitting software and skills of translating 2D pattern into 3D garment. The study of 3D virtual fitting includes not only the knowledge of garment pattern and garment sewing but also the understanding of the function of virtual fitting software and the evaluation method of the virtual fitting effect. Teaching contents include import of file → inspection and correction of 2D patterns → adjustment of mechanical properties of simulated sample fabric → setting of the size of virtual model → adjustment of the spatial position of patterns and sewing → simulation of try-on → evaluation of simulation effect of 3D clothing try-on.

Evaluation methods

As is explained in the previous section, there are 3 evaluation procedures involved in this research, namely Process evaluation, Summary evaluation, and Self-evaluation. In this section, the general procedure and data analysis methods of the involved evaluation will be explained.

Process evaluation

Scores were given to students of two experiments (*Experiment I* and *Experiment II*), which was used as the index of procedural evaluation. Teachers recorded the time for each student in each group to complete the fitting task of the same ready-to-wear garment, and the evaluation scores of the performance of the students were given according to different completion times, as is shown in table 1. After all the students finished their virtual fitting, their works were numbered and named as 60 anonymous files, and the students corresponding to each file were only known by teachers. 60 anonymous documents were randomly distributed to 60 students five times to ensure that each student's clothing received evaluations five times. At the same time, five teachers from the fashion department of Soochow University were asked to evaluate 60 sets of clothing respectively. The students' procedural evaluation score is the score corresponding to the speed of fitting (20%), plus the score evaluated by classmates (30%) and the score evaluated by teachers (50%), totalling 100 points.

We provided a scoring scale for teachers and students, which include three parts: overall effect, completion degree and details. The completion degree is

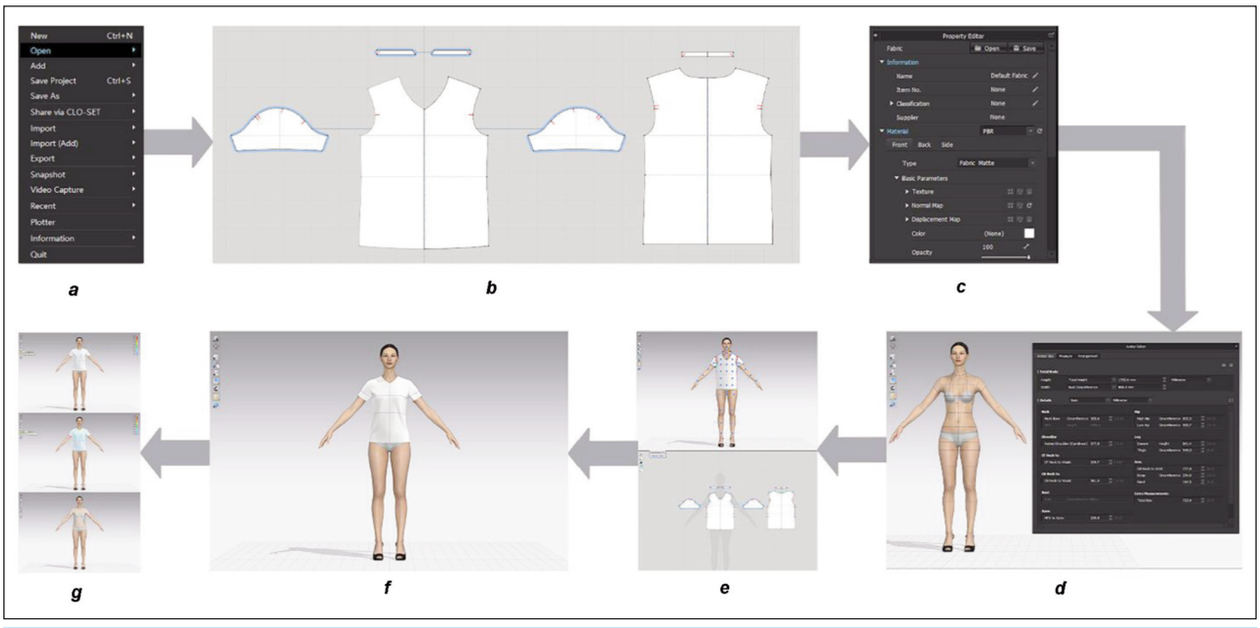

Fig. 2. A case study for the virtual fitting process: *a* – import of file; *b* – adjustment of 2D patterns; *c* – adjustment of fabric properties; *d* – setting of size of virtual model; *e* – adjustment of spatial position of patterns and sewing; *f* – simulation of try-on; *g* – evaluation

Table 1

COMPLETION TIME OF VIRTUAL FITTING AND ITS CORRESPONDING SCORE

Time (h)	≤2	2~3	3~4	4~5	>5
Score	100	90~100	80~90	70~80	60~70

divided into the completion degree of different garment parts (whether the sewing of the collar, sleeve, placket and other parts is completed, fabric attributes are set, etc.). The detailed score is given according to the quality of the finished part (whether the sewing lines of each part are accurate, the fabric attributes are set reasonably and the folding angle is set correctly as well as the aesthetic aspects about wrinkles, stitches, prints, etc.).

Summary evaluation

One month after the end of the experiment above, another set of experiments was performed to access the skills regarding the virtual fitting of the group of the involved students in *Experiment I* and *Experiment II,* including Garment 1 (the ready-to-wear clothing they have learned in class) and Garment 2 (a brand-new complex style clothing), which was assessed in a limited time (3h). The final clothing evaluation was completed by 10 teachers from the fashion department of Soochow University with a total score of 100 points (using the same scoring scale as process evaluation).

Self-evaluation

This study should not only pay attention to the objective learning effect under collaborative learning mode but also pay attention to students' subjective views on collaborative learning mode. Questionnaires were distributed to the students in *Experiment II* group, which included 15 questions in four aspects: classroom feelings, knowledge mastery, learning ability and comprehensive ability.

Statistical methods

Adopting SPSS statistical software, the measurement data is expressed as ($\overline{x} \pm s$), where $\overline{x}$ is the mean and s is the standard deviation. T test was used for independent samples between groups, and the counting data was expressed in (%).

T test calculation equation is the following:

$$t = \frac{\overline{X}_1 - \overline{X}_2}{\sqrt{\frac{(n_1-1)S_1^2 + (n_2-1)S_2^2}{n_1+n_2-2}\left(\frac{1}{n_1}+\frac{1}{n_2}\right)}} \quad (1)$$

$\overline{X}_1$, $\overline{X}_2$ are the mean of two samples, S_1^2, S_2^2 are the variance of two samples, and n_1, n_2 are the capacity of two samples.

EXPERIMENTS AND RESULTS

Experiments

Experiment I teaching methods and final examine

Experiment I adopted the traditional teaching methods. In the learning process, students will follow the instructions of the teachers for every single step of the software operation. Teachers demonstrated the fitting process of a set of garment block and a set of ready-to-wear garments respectively. Students practiced the fitting of garment block under the instruction of teachers and then completed the virtual fitting of a ready-to-wear garment according to their memory or notes by themselves. Teachers played a leading role in the whole teaching process, students received knowledge passively, and there was no interaction among students in the class. Students could ask teachers for advice when they encountered problems. One month after the end of the experiment

above, students in *Experiment I* would finish the virtual fitting exam in a limited time, which includes Garment 1 (Ready-to-wear clothing they have learned in class) and Garment 2 (Brand-new clothing).

Experiment II teaching methods and final examine

Experiment II adopted the teaching method of collaborative learning. There are seven basic concepts of collaborative learning: competition, debate, cooperation, problem-solving, partnership, design and role-playing [16]. The 3D virtual fitting experiment can be taught using the concept of competition, cooperation and problem-solving. All the students were divided into 12 groups and there were 5 students in each group. The competition between groups was employed before the class. Printed instructions were distributed to each student in each group, and the garment sample to be used in the experiments was the same as that of the control group which is a garment block. First, each group of students were given 1 h to read and discuss the printed instructions, and then completed the fitting tasks of a set of clothes with the same ready-to-wear garment as the control group. During the fitting procedure, students were allowed to communicate and discuss with each other, and teachers could give additional instruction when the students encountered problems. One month after the end of the experiment above, students in *Experiment II* would finish the virtual fitting exam in a limited time, which included Garment 1 (Ready-to-wear clothing they have learned in class) and Garment 2 (Brand-new clothing).

Results

There are three different results involved in this study: i) procedural evaluation results; ii) summary evaluation results; iii) questionnaire survey results. Tables 2, 3 and 4 present these results respectively

The summary evaluation scores of the control group and the experimental group are shown in table 3.

A total of 60 questionnaires were distributed and 60 questionnaires were recovered, with a recovery rate of 100%. Descriptive statistical results of students' views on group collaborative learning model are shown in table 4 ($n = 60\%$).

DISCUSSION

Table 2 discusses the process evaluation of the involved experiments. It can be seen from table 2 that regarding the speed score, the result of *Experiment II* is higher than that of *Experiment I* in the process evaluation, indicating that the students in *Experiment II* can complete the complex style virtual fitting faster than students in *Experiment I*, and that the collaboration within the group and the competition between the groups can motivate the students to complete the task quickly. In addition, the evaluation score given by students and teachers in *Experiment II* is higher than that in *Experiment I*, which manifests that the collaborative learning mode can improve their learning efficiency and virtual fitting exercise skills. The standard deviation of *Experiment II* is smaller than that of *Experiment I*, which indicates that the individual difference between the students in *Experiment II* is smaller. It can be deduced that the collaborative learning model is more beneficial to improve the class average level. As $P \leq 0.05$ in the T-test, there is a significant difference between the two experiments relating to the completion speed score, score given by teachers and total score. The T-test result of students' evaluation scoring is $P > 0.05$ indicates that there is no significant difference between the two experiments, which may be due to the lack of evaluation experience of students.

Table 3 discusses the summary evaluation results. It can be seen from table 3 that the P values of Garment 1, Garment 2 and the total score of the two experiments are all less than 0.05, indicating that there are significant differences in learning effects

Table 2

PROCEDURAL EVALUATION RESULTS

Type size	Number	Speed score	Student evaluation	Teacher evaluation	Total score
Experiment I	60	75.63 ± 2.54	89.82 ± 3.74	85.51 ± 2.32	84.83 ± 2.79
Experiment II	60	76.77 ± 1.35	90.75 ± 3.67	87.15 ± 2.33	86.15 ± 2.54
T value	-	3.04	1.36	3.83	2.69
P value	-	0.003	0.179	0.000	0.009

Table 3

SUMMARY EVALUATION RESULTS

Group	Number	Garment 1	Garment 2	Total score
Experiment I	60	93.46 ± 3.10	80.68 ± 4.65	87.07 ± 3.88
Experiment II	60	95.38 ± 2.21	86.34 ± 3.35	90.86 ± 2.78
T value	-	3.87	7.58	6.10
P value	-	0.000	0.000	0.000

Table 4

QUESTIONNAIRE SURVEY RESULTS					
Question	**Totally agree**	**Agree**	**Uncertain**	**Disagree**	**Totally disagree**
Recognition of collaborative learning model	35.0	36.7	10.0	10.0	8.3
Improve the enthusiasm of learning	43.3	38.3	8.3	6.7	3.3
Classroom atmosphere active	53.3	28.3	13.3	5.0	0
Conducive to analysing and solving problems	20.0	48.3	10.0	11.7	10.0
Conducive to understanding and mastering knowledge	51.7	31.7	5.0	8.3	3.3
Improve the experimental skills	38.3	36.7	10.0	10.0	5.0
Improve software skills	40.0	33.3	15.0	8.3	3.3
Improve professional knowledge	50.0	31.7	5.0	10.0	3.3
Improve the ability of autonomous learning	46.7	43.3	1.7	3.3	5.0
Improve the ability to cooperate	56.7	36.7	3.3	3.3	0
Improve the communication ability	51.7	33.3	5.0	5.0	5.0
Improve the sense of responsibility to the team	31.7	41.7	8.3	11.7	6.7
Improve the fun of classroom learning	28.3	33.3	11.7	8.3	1.7
Improve self-confidence	33.3	31.7	16.7	10.0	8.3
I also want to learn other courses in the mode of collaborative learning	40.0	33.3	16.7	8.3	1.7

between the two experiments. The scores of Garment 1 and Garment 2 in *Experiment II* are higher than those in *Experiment I*, and the standard deviation is lower than *Experiment I*, which indicates that the collaborative learning mode is more conducive to maintaining the learning effect and eliminating the individual differences among students in the group. The scores of Garment 1 in both experiments are obviously higher than those of Garment 2, because Garment 1 is the same as the clothing practiced in class, which verified that the practice in class enhances the students' memory of the virtual fitting process of Garment 1, while Garment 2 is a new style that students are not familiar with, which makes Garment 2 scores much lower than Garment 1. However, the score of Garment 2 in *Experiment II* was significantly higher than that in *Experiment I*, which indicates that the collaborative learning mode is more helpful for students to improve their capacity of analysing problems and drawing inferences from others.

Table 4 shows the descriptive statistical results of students' views on the group collaborative learning model. It can be seen from table 4 that, in general, 71.7% of students basically approve of collaborative learning mode, and 73.3% of students want to learn more courses in collaborative learning mode. Academically, 68.3% of the students think that collaborative learning is beneficial to analysing and solving problems, more than 70% of them think that collaborative learning has improved their exercise skills and software knowledge, more than 80% think that collaborative learning has improved their professional knowledge, ability to acquire knowledge and communication skills, and more than 90% think that collaborative learning has improved their autonomous learning ability and cooperation ability. Psychologically and socially, more than 80% of the students think that collaborative learning has aroused their learning enthusiasm, 73.4% of the students think that collaborative learning has improved their personal sense of responsibility to the group, and more than 60% of the students think that collaborative learning has improved their classroom learning pleasure and self-confidence. It is inferred that students generally hold a positive attitude towards the group collaborative learning mode, which verifies the advantages of collaborative learning compared with traditional teaching methods. It is obvious that the collaborative learning mode is conducive to cultivating students' comprehensive abilities in autonomous learning, cooperation with others, communication and so on, and stimulating students' interest in learning and sense of honour and responsibility.

Williamson et al. report a study evaluating the implementation of collaborative learning in practice models at a university school of nursing and midwifery with practice partners across the South West of England. They found that collaborative learning is more helpful for nurses to contact and adapt to nursing practice than traditional instruction method in exercise courses [17]. In the research of Vijayalakshid et al., the second-year students of fashion design and marketing adopted collaborative learning method in a fashion design course. They evaluated the effectiveness of the collaborative learning method, finding that the method is efficient and they received positive response from students through questionnaire [18]. Different from the realistic practical operation and theoretical design, virtual simulation experiment is a practical operation in the virtual environment.

However, this study proves that the collaborative learning mode is also applicable in virtual simulation practice teaching.

It cannot be ignored that some students don't recognize the collaborative learning model, which also shows that the collaborative learning model has some drawbacks and can't be applied to all students. For example, some students are introverted and not good at communication, but their abilities are limited by the influence of others in collaborative study groups. In addition, some students have accustomed to the thinking mode of passively accepting knowledge because of long-term traditional teaching, but they can't accept the novel collaborative learning mode for a while. Teachers' position in collaborative learning is still important, and they should actively guide and supervise classroom discipline, so as to prevent students from being too active to discuss the content irrelevant to the classroom and some students from relying on their peers in the group to be lax and lazy.

CONCLUSION

In this paper, we investigated the application of collaborative learning in fashion related virtual simulation exercise. Our research consists of a group of control experiments (traditional teaching method and collaborative learning method) and three evaluations (process evaluation, summary evaluation and questionnaire survey). The results show that collaborative learning is more conducive to improving students' learning efficiency, maintaining students' memory of knowledge and skills, improving students' comprehensive ability and activating classroom atmosphere, and through questionnaires, most students generally adopt a supportive attitude towards collaborative learning. Therefore, it can be considered that the collaborative learning mode is more suitable for virtual fitting exercising teaching than the traditional teaching method. The collaborative learning method is anticipated to be used in other virtual simulation exercise teaching such as virtual garment pattern generation, virtual anthropometry. However, the questionnaire survey results show that a few students do not accept the collaborative learning mode. It indicates that our future researches will focus on optimizing collaborative learning in virtual simulation exercising teaching and making it applicable to all students.

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