Research on experiment teaching of anthropometry and virtual clothing design based on Gagné information processing theory

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ABSTRACT – REZUMAT

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With the promotion of education informatization in colleges and universities, virtual simulation technology is increasingly used in experimental teaching. In the teaching of fashion-related majors, virtual simulation technology can help students quickly and efficiently understand design theories, which are difficult for them to understand. However, due to the complexity of the virtual simulation experiment, it is difficult for students to master all the techniques required for the operation of the experimental system in a short time. In traditional teaching, students passively accept knowledge taught by the teacher and follow the teacher's operation, thereby affecting the learning effect. Such teaching and learning process cannot fully functionalize students' sensory system coding, and therefore cannot form long-term memory. To optimize the application of virtual simulation technology in the teaching of fashion-related majors, this paper proposes a clothing virtual simulation experimental teaching method based on Gagné information processing theory. To verify its effectiveness, anthropometry and virtual clothing design experiment was adopted as the research object. Two groups of students were involved in the experiments. One group was taught traditionally while another group was taught by the Gagné information processing mode. Through a set of learning and teaching process evaluation, experiment results demonstrated that Gagné information processing mode can effectively help students to fine-process the knowledge they have learned, so that important information can be extracted and encoded to form long-term memory. This paper provides support for future Gagné information processing theory in the teaching of virtual simulation courses and exercises.

Keywords: *information processing mode of Gagné, virtual simulation, virtual clothing design, exercise teaching, control experiment*

Cercetare privind predarea experimentală a antropometriei și a designului virtual de îmbrăcăminte bazată pe teoria procesării informațiilor Gagné

Odată cu promovarea informatizării educației în colegii și universități, tehnologia de simulare virtuală este din ce în ce mai utilizată în predarea experimentală. În predarea specializărilor legate de modă, tehnologia de simulare virtuală poate ajuta studenții să înțeleagă rapid și eficient teoriile de design, care sunt greu de înțeles pentru ei. Cu toate acestea, din cauza complexității experimentului de simulare virtuală, studenților le este dificil să stăpânească toate tehnicile necesare pentru funcționarea sistemului experimental, într-un timp scurt. În predarea tradițională, studenții acceptă pasiv cunoștințele predate de profesor și urmează instrucțiunile profesorului, influentând astfel procesul de învățare. Un astfel de proces de predare și învățare nu poate funcționa pe deplin în codificarea sistemului senzorial al studenților și, prin urmare, nu poate forma memoria pe termen lung. Pentru a optimiza aplicarea tehnologiei de simulare virtuală în predarea specializărilor legate de modă, această lucrare propune o metodă de predare experimentală de simulare virtuală a îmbrăcămintei bazată pe teoria procesării informațiilor Gagné. Pentru a-i verifica eficacitatea, antropometria și experimentul de design vestimentar virtual a fost adoptat ca obiect de cercetare. Două grupuri de studenți au fost implicate în experimente. Predarea pentru un grup a fost efectuată în mod tradițional, în timp ce predarea pentru un alt grup a fost efectuată prin modul de procesare a informațiilor Gagné. Printr-un set de evaluare a procesului de învățare și predare, rezultatele experimentului au demonstrat că modul de procesare a informațiilor Gagné poate ajuta în mod eficient studenții să proceseze cunoștințele pe care le-au învățat, astfel încât informațiile importante să poată fi extrase și codificate pentru a forma memoria pe termen lung. Această lucrare oferă suport pentru viitoarea teorie Gagné de procesare a informațiilor în predarea cursurilor și exercițiilor de simulare virtuală.

Cuvinte-cheie*: modul de procesare a informațiilor Gagné, simulare virtuală, design virtual de îmbrăcăminte, predarea exercițiilor, experiment de control*

INTRODUCTION

Learning through virtual simulation is proving to be an enormously beneficial resource for both students and professionals [1]. For professionals, virtual simulation can help them to see the result of the design at any time during the design process to verify the feasibility of the design, without making a physical object [2]. For students, it could be used in the learning

process and allows the learner to operate instantly after watching a step-by-step simulation procedure [3]. It is therefore a new emerging supportive technology for digital teaching. In the traditional teaching method, students are passively receiving knowledge and only their human aural and the visual system will be involved. But in the learning process via virtual simulation, students will participate actively, engage their brains and learn by doing [4]. It means that other parts of the human cognitive system will be also involved to support the learning process. Learning through virtual simulation is proven to be a safe, efficient, and low-cost method, especially for operational skill learning [5].

Although virtual simulation can simulate the real world and carry out the operations in the virtual environment, to a certain extent, it is still different from real operations in the real world [6]. Therefore, students' awareness of using virtual simulation needs to be improved. According to related theories of pedagogy, in the process of operational skill learning, the key factors that will affect the operational skill learning effect are “short-term memory” and “long-term memory” in the processing of skill-related operational information [7]. If the input skill-related information is encoded by the learner’s sensory register and enters the short-term memory, it will be simply processed and quickly enters the reaction generator [8]. It is therefore difficult to be stored. If the skill-related information enters the long-term memory, it can be finely processed and coded. Relevant information will be transferred to the long-term memory, and then can be stored well [9]. In this context, when designing operational experiments, it is necessary to fully consider how to enable students to fine-process information, so that important information can be focused on or selected by students as the central object of attention so that important information can be transferred to long-term memory.

Information processing theory was proposed by American educational psychologist Robert Gagné in 1974, which combines cognitivism and behaviourism, regards people as the mechanism of information processing, regards cognition as the processing of information and believes that learning is constituted by the acquisition and use of information [10]. Information processing theory emphasizes the validity of the acquisition, which is a potential individual state of mind or mental quality, under certain conditions or situations that can be demonstrated by the explicit act or condition of an individual, focusing on the application of knowledge in a real environment [11]. Information processing theory divides the teaching process into nine stages: attract attention, inform learning goals, arouse memories, present stimulating materials, provide learning guidance, elicit behavioural performance, provide feedback, measure behavioural performance, and promote knowledge retention and transfer [12]. This teaching mode is conducive to the effective communication of information between teachers and students and promotes students to form long-term memory of knowledge in practice [13]. Gagné information processing theory is considered to be the most appropriate method to solve the problems in virtual simulation experiment teaching. It is therefore we propose in this study a Gagné information processing theory-based virtual simulation experiment teaching method.

Fashion is a discipline combining theoretical knowledge (design theory, fashion history, fashion marketing theory, etc.) and skill-oriented knowledge (pattern making, sewing, prototyping) [14]. With the support of virtual simulation, skill-oriented experimental projects, such as fabric development, garment design, clothing manufacturing, clothing trade and fashion marketing could be realized in an open and independent experiment environment [15]. Therefore, more and more fashion institutes are involving virtual simulation tools in different fashion-related subject teaching. Currently, due to technical reasons, compared with other fashion subjects, virtual simulation technology is more widely used in anthropometry and virtual clothing design experiment.

Based on the analysis of the shortcomings in the experimental teaching using virtual simulation, this study takes anthropometry and virtual clothing design experiment as an example and explores the influence of the Gagné information processing theory on the experimental teaching effect of anthropometry and virtual clothing design experiment. Two comparative experiments are designed to teach anthropometry and virtual clothing design experiments. One group of experimental samples is carried out using the teaching mode guided by Gagné information processing theory, while the other is carried out using the traditional method. The effect of the involved two different teaching methods is evaluated through a set of learning and teaching evaluation, including process evaluation, cognitive evaluation and self-evaluation.

The rest of this paper is organized as follows: in the research framework section, the tools and evaluation methods of the whole paper are introduced. The third section comprises two experiments. Experiment I aims to study the learning effect of students in anthropometry and virtual clothing design experiment in the traditional way. The influence of Gagné information processing theory on teaching effect is investigated in Experiment II. At the end of the third section, the results of the two experiments are evaluated. Finally, the fourth section is the conclusion and prospect.

METHODOLOGY

Research framework

In this study, the method of the comparative experiment is applied to anthropometry and virtual clothing design experiment to explore the influence of Gagné information processing theory on the effect of experiment teaching. The research framework of this study is shown in figure 1. A total of 60 students majoring in Fashion Design and Engineering from the College of Textile and Apparel Engineering, Soochow University

in 2018 (60 students) were divided into two experimental groups of 30 each in order of Student ID Number was selected as the experimental samples. The first 30 students were in the control group and the rest 30 students were in the experimental group. The two sets of experiments were carried out simultaneously from September 14, 2020, to September 21, 2020.

In *Experiment I*, the teacher used the traditional teaching model to teach the control group. These students were aged (21.2 ± 2.2 years), including 4 males and 26 females. In *Experiment II*, the teacher used Gagné information processing theory to teach the experimental group. These students were aged (21.3 ± 2.1 years), including 5 males and 25 females. The instructors, teaching content and teaching materials of the students in the two groups were the same, and there was no statistically significant difference between the scores in the college entrance examination of the two groups ($P > 0.05$).

This research takes the teaching mode as the independent variable, and the student's final grade as the dependent variable, which can intuitively reflect the difference in teaching effect between the two different teaching modes. The entire experimental design is based on the single factor principle to ensure the validity of the experimental results. The evaluation of experimental results mainly includes three aspects: process evaluation, cognitive evaluation and self-evaluation of experimental group students. Process evaluation refers to the performance evaluation obtained by the two groups of students in teaching, which is the students' short-term memory of knowledge. Cognitive evaluation is the evaluation of students' inner learning motivation under the same incentive, which is carried out one month after the end of the experiment. The evaluation standard is the students' long-term memory of knowledge. Self-evaluation is the evaluation of the teaching effect of Gagné information processing theory by the students in the experimental group.

Learning materials

Anthropometry and virtual clothing design experiment is an important subject of clothing virtual simulation experiment [16]. Its purpose is to enable students to understand the relationship between anthropometry and fashion design, mastering the relevant professional skills. The experiment requires students to master basic anthropometric methods and knowledge of clothing structure, which is of great significance for students to understand the relationship between ergonomics and fashion design.

Experiment I and *Experiment II* are mainly realized through the automatic anthropometric system and the automatic pattern generation system. The specific procedures are shown in figures 2 and 3. Firstly, the non-contact anthropometric system is an anthropometric method using image processing technology, which directly extracts the body data information of the tested person through the front and side photos. It is used to obtain the height, chest circumference, shoulder width and other data information of the subject. Then the three-dimensional human body model of the subject is automatically generated in the human body three-dimensional simulation model generation system. Based on the basic data of the human body in ergonomics, including human body structure, human body scale and human action domain, rationalize the details of the human body model generated by the system, and extract the human body data needed to make the prototype.

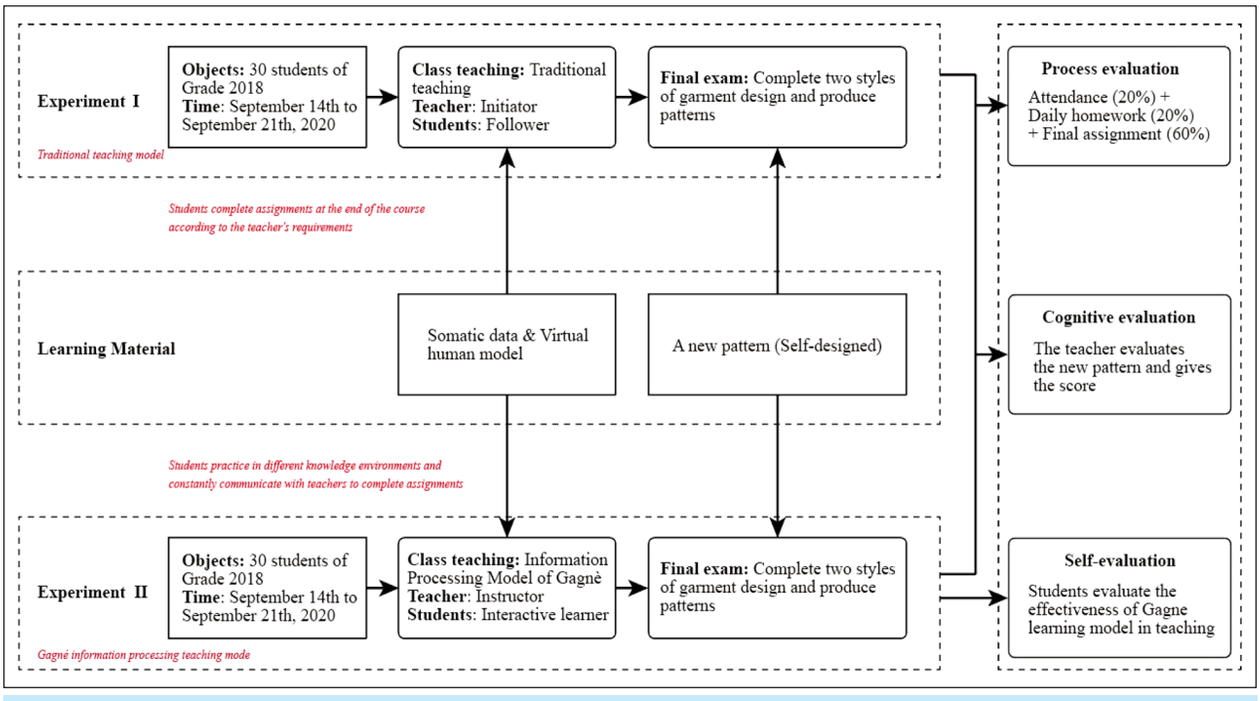


Fig. 1. Framework of this research

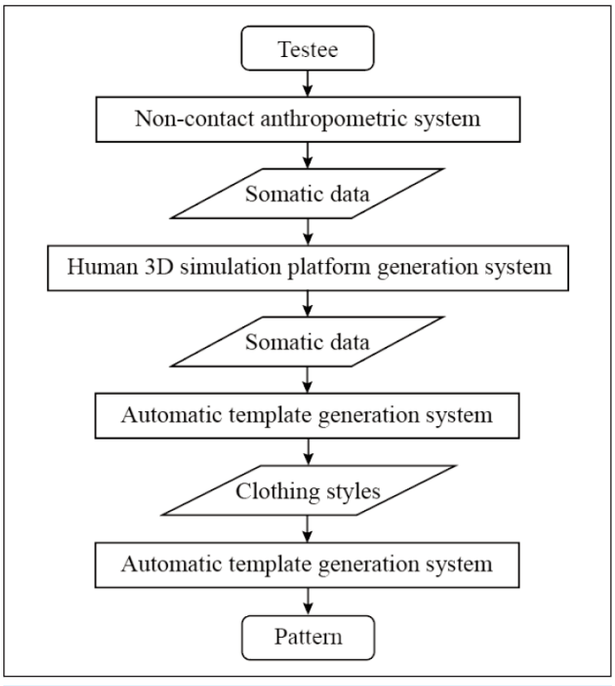


Fig. 2. Experiment flow of anthropometry and virtual clothing design

Finally, input the data into the automatic pattern generation system and select the style that meets the design requirements in the database [17]. The system automatically will generate the corresponding clothing pattern.

Evaluation methods

Process evaluation

The scores obtained by students in experiments (*Experiment I* and *Experiment II*) will be used as evaluation indicators for process evaluation. Due to the change of teaching mode, the teaching interaction between teachers and students has increased, and each student will communicate with teachers. As a result, students' attendance rate and grades will also change. Teachers give the scores based on students' attendance and evaluate the periodic assignments submitted by students during the teaching process. After all, students have completed the virtual costume design, the teacher will make a comprehensive evaluation of their final works (2 sets in total). The composition of the process evaluation score is attendance (20%) + Daily homework (20%) + final work (60%). The evaluation criteria are as follows (tables 1, 2 and 3).

Table 1

ATTENDANCE TIMES AND CORRESPONDING SCORES					
Day	7	6	5	4	<4
Score	20	18	15	12	0

Table 2

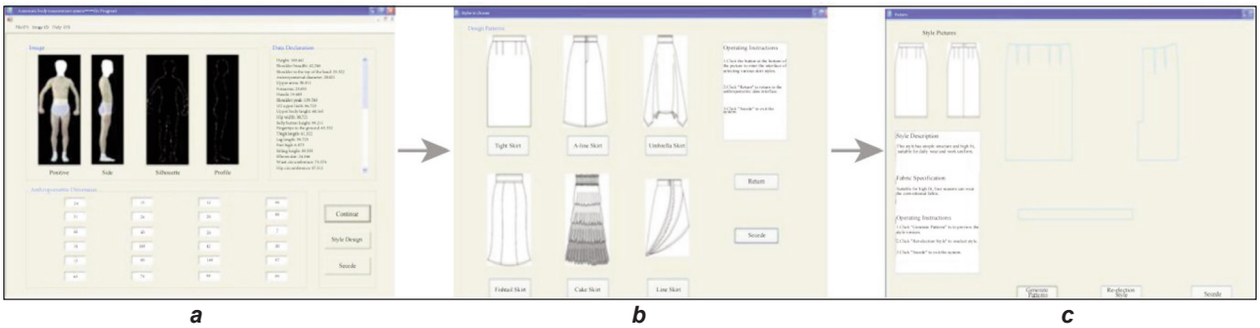
DAILY HOMEWORK AND CORRESPONDING SCORES				
Daily homework	**Anthropometric data**	**Virtual human generation**	**Style**	**Pattern**
Score	5	5	5	5

Table 3

FINAL WORK EVALUATION AND CORRESPONDING SCORES					
Work	**Anthropometric data**	**Virtual human generation**	**Style**	**Pattern**	**Time**
Score	10	10	10	10	20

Cognitive evaluation

One month after the end of the above experiment, another set of experiments was carried out. The experiment content is the same as the above experiment. Students are required to complete a set of virtual clothing design which is completely different from the teaching of *Experiment I* and *Experiment II* within the specified time, including new human body data measurement, generation of new virtual human models, and new clothing categories and templates. The final score of the experiment will be assessed by 10 teachers from the Department of Fashion Design and Engineering of the College of Textile and Apparel Engineering, Soochow University, totalling 100 points. The results of the experiment are used in the



a *b* *c*

Fig. 3. An example of anthropometry and virtual clothing design: *a* – anthropometric data measurement and results; *b* – clothing style selection; *c* – clothing pattern automatic generation

evaluation of students' long-term memory effects under two different teaching modes.

Self-evaluation

This research explores the influence of Gagné information processing theory on the teaching effect of clothing virtual simulation experiment while starting from humanism to focus on students' evaluation of the teaching effect of the new teaching model. Therefore, after the end of the experiment teaching, questionnaires will be issued to the students participating in Experiment II, including the students' evaluation of classroom atmosphere, knowledge cognition, learning attitude and comprehensive ability

Statistical methods

SPSS software was used for data processing and analysis. The statistic is expressed as ($\overline{X} \pm S$), where $\overline{X}$ is the mean and S is the variance. T test was used for data analysis of independent samples between groups, and the counting data was expressed in (%). T test calculation formula is:

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

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

EXPERIMENTS AND RESULTS

Experiments

Experiment I: Anthropometry and virtual clothing design experiment in the traditional way

Experiment I adopted the traditional teaching methods. The students had not been exposed to the knowledge of the experimental background and content before the start of the course. In the teaching process, the teacher first explained the background knowledge related to the experiment and demonstrated the operation of the experimental system. Students operated the experimental system according to the teacher's explanations, according to short-term memory to complete the entire experiment, including inputting front and side photos of the human body, extracting anthropometric data, choosing clothing styles and generating corresponding clothing patterns. Throughout the experiment, the teacher had an absolute dominant position. The students passively accepted knowledge and formed short-term memory through mechanical memory. There was no interaction between the student and the teacher. A month after the above experiment, students will complete the anthropometry and virtual clothing design experimental test within the specified time. A month after the above experiment, students should independently design a set of clothing patterns within the specified time, which is different from the previous one, to complete the anthropometry and virtual clothing design experimental test.

Experiment II: Anthropometry and virtual clothing design experiment in Gagné information processing mode

Experiment II adopted Gagné information processing theory. The teacher had informed the students of the experiment content and objectives before the start of the experimental teaching, and the students had independently previewed the knowledge related to the experiment. During the teaching process, students can discuss experimental knowledge with the teacher. The teacher will demonstrate the operation of the experimental system corresponding to each step of the experiment in turn. When the teacher performed the operation, the students could perform the operation synchronously and communicate with the teacher on the problems that arise. After the teacher finished all the demonstrations, the students extracted information based on the short-term memory formed before and formed effective long-term memory in the operation of the experimental system. According to the specific requirements of the experiment, the information in the long-term memory is extracted to complete the entire experiment, including inputting anthropometric data, generating a virtual human model, choosing clothing styles and generating corresponding clothing patterns. Throughout the experiment, the teacher appeared as the instructor, and the students and the teacher continued to interact with each other and formed a thinking mode to solve similar experimental problems through knowledge transfer. One month after the above experiment, students should independently design a set of new clothing patterns within the specified time to complete the anthropometry and virtual clothing design experimental test.

Results

There are three different results involved in this study: (1) process evaluation; (2) cognitive evaluation; (3) student self-evaluation. Tables 4, 5 and 6 present these results respectively.

Table 4

PROCESS EVALUATION RESULTS					
Type size	**Number**	**Attendance**	**Daily homework**	**Final work evaluation**	**Total score**
Experiment I	30	18.73213	17.50436	50.13232	86.36310
Experiment II	30	19.67075	19.26112	54.94233	93.87221
T value	-	9.82	8.71	3.83	3.87
P value	-	0.030	0.039	0.000	0.000

Table 5

COGNITIVE EVALUATION RESULTS		
Type size	**Number**	**Total score**
Experiment I	30	84.68±4.65
Experiment II	30	90.34±3.35
T value	-	7.58
P value	-	0.000

A total of 30 questionnaires were distributed and 30 questionnaires were recovered, with a recovery rate of 100%. Descriptive statistical results of students' views on Gagné information processing mode are shown in table 6 (n = 30, %).

Discussion

It can be seen from table 4 that in the process evaluation, the average scores of the experimental group are higher than those of the control group. This shows that the students who use Gagné information processing theory for course learning are more likely to form long-term memory of knowledge. This makes students a deeper understanding and mastery of knowledge. In addition, the attendance of students in the experimental group is significantly better than that of the control group. This proves Gagné information processing theory can enable students to better learn and apply professional knowledge. The process of interacting with the teacher can stimulate students' enthusiasm and enthusiasm for learning. Except for the similar standard deviations of the final homework scores graded by the teacher, the standard deviations of the scores of other items in the experimental group were significantly smaller than those of the control group. This proves that Gagné information processing theory is more conducive to the improvement of students' overall academic performance and is more suitable for class teaching activities. As $P \leq 0.05$ in the T test, there is a significant difference between the two groups relating to attendance, daily homework, final homework and total score.

The cognitive assessment test is conducted a month after the end of the course. It can be seen from table 5 that in the cognitive evaluation, the P value of the scores of the experimental group and the control group is less than 0.05, which indicates that the scores of the two groups are significantly different. The average score of the experimental group is higher than that of the control group, which shows that the students in the experimental group have significantly higher knowledge transfer ability than the control group in dealing with professional problems with similar knowledge background. This proves that Gagné information processing theory is more conducive to maintaining students' learning effects and forming students' long-term memory of knowledge and skills. The standard deviation of the number of experimental components is smaller than that of the control group, which shows that Gagné information processing theory can eliminate differences between students and is more suitable for class teaching.

As seen from table 6, overall, 76.7% of the students recognized Gagné information processing theory and 80% of the students hope to continue to learn other courses in Gagné information processing theory. In terms of learning atmosphere, 80% of students believe that Gagné information processing theory has enlivened the classroom atmosphere and improved their learning enthusiasm. 66.6% of students believed that Gagné information processing theory has improved their communication skills. In academic terms, 70% of students believe that Gagné information processing theory is conducive to analysing and solving problems. 53.4% of students believe that Gagné information processing theory is conducive to understanding and mastering the knowledge they have learned. 90% of the students think that Gagné information processing theory is

Table 6

SELF-EVALUATION RESULTS					
Item	**Totally agree**	**Agree**	**Uncertain**	**Disagree**	**Totally disagree**
Recognize the Gagné information processing theory	40.0	36.7	16.7	3.3	3.3
Improve the enthusiasm of learning	43.3	36.7	10.0	6.7	3.3
Classroom atmosphere active	56.7	23.3	13.3	6.7	0
Conducive to analyzing and solving problems	46.7	23.3	16.7	3.3	10.0
Conducive to understanding and mastering knowledge	36.7	16.7	33.3	10.0	3.3
Improve the communication ability	43.3	23.3	10.0	16.7	6.7
Improve professional knowledge	66.7	23.3	10.0	0	0
Improve the ability of knowledge transfer	40.0	23.3	16.7	16.7	3.3
I also want to learn other courses in the mode of the Gagné information processing theory	43.3	36.7	10.0	6.7	3.3

helpful to the learning of professional knowledge and 63.3% of the students think it improves their professional skills. It can be seen that students generally have a positive attitude toward Gagné information processing theory, which verifies the advantages of Gagné information processing theory over traditional teaching methods.

It cannot be ignored that there are still some students who do not recognize Gagné information processing theory, which shows that it also has certain drawbacks and cannot be suitable for all students. For example, some introverted students may affect the effect of learning feedback due to their personality problems in the process of communicating with teachers. In addition, due to the long-term acceptance of the traditional teaching mode, some students need some time to adapt to the new teaching mode, which will also affect students' evaluation of the new teaching mode. As the main body of education in Gagné information processing theory, teachers should guide students, help students change their learning thinking, adapt to the new teaching model, and improve learning efficiency.

CONCLUSION

In this paper, we investigated the application of Gagné information processing theory in anthropometry and virtual clothing design experiment. Our research consists of a set of control experiments (traditional teaching methods and Gagné information processing theory) and three evaluations (process evaluation, cognitive evaluation and student self-evaluation). The results show that Gagné information processing theory is more conducive to improving students' learning enthusiasm, enabling students to form long-term memory of knowledge, behaviour patterns, and new cognitive strategies in practice, to achieve the effect of cultivating students' knowledge and skill transfer ability. At the same time, it can be seen that most students prefer to be taught by Gagné information processing theory and are willing to continue to use this model for course learning through student self-evaluation. It can be verified that Gagné information processing theory is suitable for anthropometry and virtual clothing design experimental teaching. It has more advantages compared with the traditional teaching model, which provides a theoretical basis for the application of Gagné information processing theory in education reform in the future. However, the results of the questionnaire survey showed that a small number of students did not support Gagné information processing theory. Therefore, the future research direction will tend to improve the learning experience of these students in Gagné information processing theory and formulate a teaching plan suitable for all types of students. To maximize the advantages of Gagné information processing theory.

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