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Research Article

Flipped Classroom for Motor Skills: What Factors Influence College Students' Learning Effect?

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The study of motor skills is an essential course item for college students. Many college teachers try to introduce the flipped classroom mode into the teaching of motor skills. However, the influence of this mode on the learning effect of college students' motor skills is uncertain. This paper builds a research model on the basis of literature review. This model is used to analyze the influence factors of flipped classroom on the learning effect of college students' motor skills. Through questionnaire survey and empirical analysis, we verified the research hypothesis of each factor. The results show that video technical action display, video feedback of students' technical action, and teaching interaction have a significant positive impact on the learning effect of college students' motor skills in the flipped classroom, while video theory teaching has no significant impact. This study expands the application of flipped classroom in the field of motor skills and enriches the relevant literature of flipped classroom mode. Based on the findings of this study, we make the following recommendations: (1) teachers can use the way of video recording to display technical actions of motor skills, (2) students can use video feedback to communicate with the teacher about the learning of motor skills, and (3) flipped classroom needs to pay attention to the teaching interaction between teachers and students.

1. Introduction

In the process of physical education in colleges and universities, the study of motor skills is becoming more and more important. Motor skills refer to the ability of human body to master and effectively complete special actions in the process of movement [1]. Students' master motor skills, on the one hand, can improve the scientific nature of sports and, on the other hand, can prevent unnecessary injuries [1, 2]. Therefore, paying attention to the training of students' motor skills is an essential goal in physical education teaching. Physical education is a practical course, and the study of theoretical knowledge is equally important. Because mastering complete physical education theoretical knowledge allows students to get scientific guidance while engaging in physical activity [3].

With the progress of information [4–6] and communication technology [7, 8] and the wide application of mobile smart phones [9], the traditional offline teaching method is gradually changing, and online teaching [10] has been introduced into the training of motor skills courses for college students. Inspired by the thinking of online teaching, a teaching mode called flipped classroom has been applied to college students' motor skills courses. Flipped classroom refers to the realignment of time in and out of the classroom and the transfer of learning decisions from teachers to students [11, 12]. This new form of education and teaching overturns the traditional classroom teaching mode, and students gain the initiative instead of passively receiving education. This is not only a kind of role transformation but also the innovation of education mode [13].

It is conceivable that under the flipped classroom mode, students can independently learn theoretical knowledge of motor skills through video teaching at home, dormitory, or cafe [14]. In addition, students can play the course video repeatedly to get an in-depth understanding of the

characteristics of motor skills and action process and eventually form an internal movement image and correct movement concept in their mind, laying a foundation for formal practice [15]. For some exercise tasks of motor skills after class, students can submit them to their teachers by recording videos [16]. This not only plays a role in testing students' mastery of motor skills but also helps teachers fully understand each student's learning situation. The learning of motor skills is a compulsory course for college students. Many college teachers try to introduce the flipped classroom model into motor skills teaching, and the effect of this model on the learning effect of college students' motor skills is still uncertain. Therefore, this paper constructs a research model to expand the application of flipped classrooms in the field of motor skills.

However, it is controversial whether the flipped classroom mode can enhance students' learning outcomes in general. For example, Persike's [16] research shows that in flipped classrooms, one of the determinants of rising course performance is having high-quality traditional courses. When a student's course performance is already high, there may be little room for further improvement in the flipped classroom mode. Clifton and Boutell [17] put forward that flipped classroom has different learning effects for students with different learning abilities. For example, students who learn quickly and have a strong understanding ability in a flipped classroom will return to a traditional classroom feeling confident and experienced but bored by it. Those students who did not learn well enough in the flipped classroom and did not fully grasp the knowledge of the course often felt struggling and at a loss when they returned to the traditional classroom. Therefore, this study tries to answer what are the factors that affect the learning effect of college students' motor skills in flipped classroom and what are their mechanisms of influence?

Given the above analysis, we find that flipped classrooms, while having many advantages, are not without drawbacks. Therefore, it is of great significance to study the factors that may influence the learning effect of students in the flipped classroom mode. On the one hand, this study is conducive to stimulating students' enthusiasm to participate in flipped classroom, and on the other hand, it is conducive to increasing the interaction between students and teachers in motor skills of flipped classroom. In addition, this study takes motor skills learning as the research object, and explores the potential factors that affect students' learning effect under the flipped classroom mode. This study enriches the literature of flipped classroom and provides theoretical guidance for the application of motor skills in flipped classroom.

The rest of this paper is arranged as follows: the second section is literature review, the third section proposes the model construction and research hypothesis, the fourth section presents the research method and empirical results, and finally, the fifth section puts forward the conclusions.

2. Literature Review

2.1. Motor Skills. Motor skills are also called "action skills." It refers to the ability of human body to master and effectively complete special actions in the process of movement [1, 18]. In the teaching of physical education, the theory and practice of motor skills are very important [19]. Traditional physical education courses are generally carried out in an offline way. For example, in the first half of the course, the teacher explains the theoretical knowledge related to motor skills to the students, while in the second half of the course, the students practice motor skills [20]. With the development of information and communication technology and the wide application of mobile smart phones, network learning has been introduced into physical education [21]. In fact, Williams and Grant [22] have pointed out that video technology or online simulation teaching methods may be effective for the development of students' motor skills. Especially when the network technology is combined with the teaching technology, it is beneficial to the development of students' physical awareness.

Generally, the formation of students' motor skills needs to go through three stages [23, 24]: the cognitive stage, the connection stage, and the perfection stage. The first is the cognitive stage. At this stage, the practitioner mainly demonstrates the action through visual observation and mimics the exercise, using vision to control the action [25]. After a certain amount of practice, the practitioner has initially mastered a series of local actions and began to connect the independent movements. At this point, the practitioner enters the connection phase. In this stage, the practitioner's attention mainly points to the details of skills, generalizes the essential characteristics of movements through thinking analysis, gradually realizes the whole movement, and combines several individual actions into a whole [26]. Finally, there is the perfection stage. At this stage, the movements of the practitioner have established a consolidated dynamic pattern in the brain, a series of movements mastered have formed a complete organic system, and each action can be expressed in the form of linkage [27].

2.2. The Learning Method of Motor Skills in Flipped Classroom. The introduction of flipped classroom innovates the traditional physical education teaching method. Especially when it comes to motor skills, students have more autonomy and can arrange their time freely [11]. For teachers, they can record the theoretical knowledge and action points about motor skills in advance [12]. They can also perform physical demonstrations of a set of motor skills, which can also be recorded on video. For students, they can learn theoretical knowledge and action points through videos. Actions can also be imitated through the video provided by the teacher [13]. In fact, testing students' practicality is very effective in flipped classroom. For example, after every lesson, teachers can ask students to record videos of their own actions. The videos are then sent to the teacher. Teachers can judge students' mastery of motor skills through the videos provided by students [14]. It can be seen that the application of flipped classroom in physical education can, on the one hand, impart knowledge and motor skills and, on the other hand, effectively supervise and familiarize students with their learning effects in motor skills. However, some scholars have pointed out that such flipped video

teaching may be detrimental to the interaction between teachers and students [11].

Through literature review, we found that scholars have provided us with a rich literature basis for motor skills and flipped classroom. As a product of the development of modern science and technology, flipped classroom is becoming more and more popular in college teaching. Especially in college physical education courses, flipped classroom can realize the combination of theory and practice teaching. However, there is still debate about the impact of flipped classroom on student learning outcomes (e.g., Persike [16]; Clifton and Boutell [17]). Therefore, in the field of motor skills, we propose it is necessary to further explore the effect of this teaching mode. The study on this topic, on the one hand, can provide theoretical reference for the application of flipped classroom in physical education teaching and, on the other hand, can provide improvement recommendations for students in the learning of motor skills.

3. Model Construction and Hypothesis

3.1. Model Construction. We construct a model of the factors influencing the learning effect of college students' motor skills based on a literature review of flipped classrooms. As depicted in Figure 1, the four components of this theoretical model are video theory teaching, video technical action display, video feedback of students' technical actions, and teaching interaction.

3.2. Hypothesis

3.2.1. Video Theory Teaching. The teaching of theoretical knowledge is an important link of physical education curriculum. Usually, in the first few classes of the whole course, or in the first few minutes of each class, the teacher will teach the students the theoretical knowledge of motor skills. In the flipped classroom, the theoretical knowledge can be recorded into a video in advance. Students can study independently according to the schedule of the course [11]. It is worth noting that these videos can be watched over and over again. This helps students to strengthen their understanding of the knowledge points. And even if the students do not understand the point, they can also ask the teacher in the offline teaching. Therefore, video teaching is helpful for students to deepen their understanding of theoretical knowledge of motor skills in advance. But other scholars have raised concerns. For example, if students' autonomous learning ability is not strong, video learning is difficult to ensure students' learning effect. In addition, students learn theoretical knowledge in advance through videos and may feel bored in offline courses [17]. Therefore, it is very important to understand the influence of video theory teaching on students' learning effect. We choose one of these possibilities to hypothesize:

H1: There is a positive correlation between the video theory teaching in flipped classroom and the learning effect of college students' motor skills.

3.2.2. Video Technical Action Display. Flipped classroom can realize the video of various teaching contents. In physical education teaching, the imparting of motor skills is very important. It not only needs to teach theoretical knowledge to students but also needs to carry on the technical action demonstration. In offline classes, teachers teach students by demonstrating technical movements over and over again. However, this approach poses a great challenge to teachers' teaching. The application of video technology in flipped classroom reduces the teaching burden of teachers [12]. Teachers can record standard technical actions on video, and students can watch the videos over and over again. Especially for some difficult actions, students can slow down the playing speed of the video or pause the video for a specific action [14]. This is helpful for students to decompose the technical actions and then quickly understand and learn the technical actions. Based on the above discussion, we propose the following hypothesis:

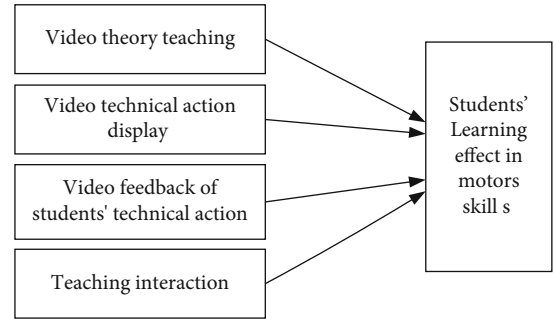

Figure 1: Research theoretical model.

H2: There is a positive correlation between the display of video technical actions in flipped classroom and the learning effect of college students' motor skills.

3.2.3. Video Feedback of Students' Technical Action. One way to test students' mastery of motor skills is to have them record videos. After teachers teach theoretical knowledge and technical actions, students need to master these points through repeated practice. However, in order to supervise the learning effect of students and to understand the learning implementation of each student, teachers can ask students to record videos for feedback [16]. This approach has the following advantages [13]: one is to give students the autonomy to submit a perfect work when they think they have practiced it perfectly; second, teachers play the role of course supervision and can understand the students' learning situation. Accordingly, we put forward the following research hypothesis:

H3: There is a positive correlation between the video feedback of students' technical actions and the learning effect of college students' motor skills.

3.2.4. Teaching Interaction. Teaching interaction has always been regarded as an important part of curriculum learning. The advantage of it is that it can activate the classroom atmosphere, enhance students' learning attention, deepen students' understanding of knowledge points, and help teachers to understand students' learning situation. However, flipped classroom may have a few disadvantages in

Table 1: Scale of observed variables.

Latent variables	Observed variables	References
Video theory teaching (VTT)	1a: I like to learn the theoretical knowledge of motor skills through videos. 1b: The teaching method of video theory has the advantage of repeated play. 1c: The teaching method of video theory enables me to arrange my learning time independently.	Herreid and Schiller [11]; Clifton and Boutell [17]
Video technical action display (VTAD)	2a: I like the way of video technical action display. 2b: This way of learning allows me to deepen my understanding of each technical action. 2c: This learning method provides me with a good opportunity to imitate practice.	Herreid et al. [12]; Mason et al. [14]
Video feedback of students' technical action (VFSTA)	3a: I think this way of learning supervision has a strong autonomy. 3b: I prefer to practice the technique very well and then record the video and send it to the teacher. 3c: The existence of such feedback mode makes me constantly remind myself to carefully study the theoretical knowledge and technical actions in the course.	Pierce and Fox [13]; Persike [16]
Teaching interaction (TI)	4a: In the process of video learning, I can only solve any question by myself. 4b: I wish there was a better way to help me answer my questions during the video learning process. 4c: Due to the lack of real-time interaction with the teacher, I felt the process of independent learning was boring.	Herreid and Schiller [11]; Cheng and Wang [15]
Students' learning effect in motors skills (SLEMS)	5a: I think the video teaching in flipped classroom will affect the effect of students in the process of learning motor skills. 5b: I think it is necessary for students to give video feedback in the process of learning motor skills. 5c: I think flipped classroom also needs to pay attention to the interaction between teachers and students.	Persike [16]; Clifton and Boutell [17]

Table 2: Descriptive statistical analysis of the survey results.

Basic information	Items	Rate	Basic information	Items	Rate
Age	15-20	8%	Whether take courses in motor skills	Yes	100%
	20-25	90%			
	>25	2%		No	0%
Gender	Male	89%	Whether know about flipped classroom	Yes	100%
	Female	11%		No	0%

terms of teaching interaction [11]. For example, if students have questions when learning recorded videos, it is difficult for them to solve them by themselves [15]. If students take notes on these questions and wait until the offline class to ask the teacher for answers, new problems may arise. For example, it is not good for students to grasp knowledge points well in the video learning stage, which may reduce their learning enthusiasm. In addition, if a large number of students have questions and the number of questions generated is also large, this may bring great challenges to the teacher's offline courses. Therefore, we propose the following hypothesis:

H4: If the teaching interaction in flipped classroom can be increased, it will promote the learning effect of college students' motor skills.

4. Methodology and Results

4.1. Questionnaire Design. We used a questionnaire design to first understand the impact of flipped classroom teaching mode on the learning effect of college students' motor skills. The questionnaire is divided into two sections. The first section contains basic information about the respondents, such as their age, gender, whether they are aware of the flipped classroom, and whether they are enrolled in motor skills courses. For this study, the basic information was used as a control variable. Video theory teaching, video technical action display, video feedback of students' technical action, teaching interaction, and students' learning effect in motor skills are the five latent variables in the second part. We used

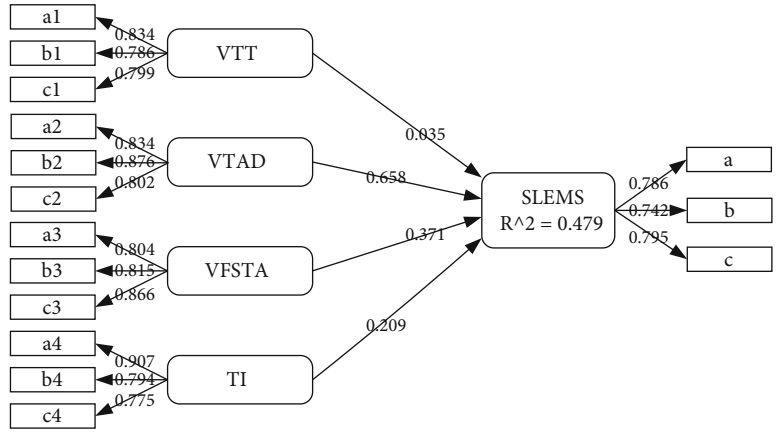

Figure 2: Model results.

a 5-point Likert scale to quantify the observed variables of each latent variable [28, 29]. The scale of the second part of the questionnaire is shown in Table 1.

4.2. Data Collection. We conducted a pretest on the designed questionnaire. The specific operation process is as follows: first, we invited three students from the motor skills course to fill in a questionnaire; second, according to their answers and the brief interview (about 5 minutes for each student), we found out the possible mistakes in the questionnaire; finally, the questionnaire was revised according to the feedback of the three testers. Our questionnaires were distributed online, and 96 questionnaires were finally recovered, 87 of which were valid, and the effective rate of questionnaire recovery was 90.6%. The survey was conducted over three weeks from May 2021. All respondents were told before taking part that the survey was anonymous and that the data would only be used for scientific research. The respondents were all from our universities, and they all took the course of motor skills. Moreover, this is a public welfare investigation. Respondents are willing to participate, and we do not offer any rewards. Descriptive statistical results of the questionnaire are shown in Table 2.

4.3. Data Analysis. We used SmartPLS software to conduct empirical analysis on the data [30]. Its principle is to use the method of PLS-SEM to build the influence factor model of flipped classroom on the learning effect of college students' motor skills. PLS-SEM model has good advantages in the treatment of small samples and the verification of the relationship between factors. In recent years, this method has been widely used in the study of influencing factors. For example, Ali and Omar [31] applied PLS-SEM model to evaluate the influence of physical environment and social environment on customer experience. Huang et al. [32] used PLS-SEM model to study the influencing factors of the crowd workers' continuous participation intention in crowdsourcing logistics. Buitrago et al. [33] used PLS-SEM model to explore the relationship between institutional quality and international competitiveness.

Table 3: Results of reliability and validity tests.

Construct	CA	CR	AVE
VTT	0.715	0.756	0.648
VTAD	0.923	0.975	0.814
VFSTA	0.821	0.883	0.756
TI	0.709	0.743	0.637
SLEMS	0.820	0.874	0.795

VTT: video theory teaching; VTAD: video technical action display; VFSTA: video feedback of students' technical action; TI: teaching interaction; SLEMS: students' learning effect in motors skills.

Table 4: Average variance extracted (AVE) square root and factor correlation coefficient.

	H	H1	H2	H3	H4
SLEMS	**0.956**				
VTT	0.379	**0.803**			
VTAD	0.458	0.225	**0.752**		
VFSTA	0.602	0.197	0.492	**0.749**	
TI	0.473	0.248	0.660	0.371	**0.680**

Diagonal elements are the square root of average variance extracted (AVE).

4.3.1. Reliability and Validity Tests. We used SmartPLS software to verify the reliability and validity of the five latent variables. The results show that the values of Cronbach's alpha (CA), combined reliability (CR), and average variance extracted (AVE) all reach corresponding thresholds [34, 35]. Meanwhile, the values of external loads for the observation variables are all greater than 0.7 (see Figure 2). Therefore, it can be considered that the model and scale constructed in this study have high reliability and validity [34, 35]. In addition, the value of R^2 is 0.479, indicating that the model we constructed has good explanatory power [35]. According to the data analysis results in Table 3 and Table 4, we find that the square root of AVE is greater than its correlation coefficient with other latent variables. This indicates that there is no multicollinearity among the latent variables [35]. Moreover, the test of model fit shows that the SRMR

Table 5: Results of hypothesis testing.

Hypothesis	Path	Path coefficient	t value	P value	Hypothesis supported?
H1	VTT → SLEMS	0.035	0.463	0.735	N
H2	VTAD → SLEMS	0.658	8.342	0.000	Y
H3	VFSTA → SLEMS	0.371	2.985	0.003	Y
H4	TI → SLEMS	0.209	2.679	0.012	Y

value is 0.042, less than 0.08. Therefore, the model constructed in this study has good fitting validity [33, 35].

4.3.2. Hypothesis Testing. The bootstrapping method of SmartPLS software was used to verify the research hypothesis. The results of the testing are shown in Table 5. Thereinto, hypotheses H2, H3, and H4 passed hypothesis verification ($P \leq 0.05$), while H1 did not ($P > 0.5$) [34, 35]. In other words, video technical action display, video feedback of students' technical action, and teaching interaction have a significant positive impact on the learning effect of college students' motor skills in the flipped classroom, while video theory teaching has no significant impact. Our findings (H2, H3, and H4) have supported the viewpoints and conclusions from Herreid and Schiller [11], Herreid et al. [12], Pierce and Fox [13], Mason et al. [14], Cheng and Wang [15], and Persike [16]. However, the finding (H1) has not confirmed the positive or negative correlation between video theory teaching and the learning effect of students' motor skills in flipped classroom. Therefore, on the hypothesis of video theory teaching, our finding is inconsistent with Herreid and Schiller [11] and Clifton and Boutell [17].

5. Conclusions

Once the flipped classroom mode was proposed, it attracted the attention of many universities and teaching staff, and more and more courses were taught in this way. The study of motor skills is an essential project for college students. Many college teachers also try to introduce the flipped classroom mode into the teaching of motor skills. However, the influence of this mode on the learning effect of college students' motor skills is uncertain. Accordingly, we built a research model on the basis of literature review. This model is used to analyze the influence factors of flipped classroom mode on the learning effect of college students' sports skills. We focus on four factors, which are video theory teaching, video technical action display, video feedback of students' technical action, and teaching interaction. Through questionnaire survey and empirical analysis, we verify the research hypothesis of each factor. The results show that video technical action display, video feedback of students' technical action, and teaching interaction have a significant positive impact on the learning effect of college students' motor skills in the flipped classroom, while video theory teaching has no significant impact.

This study expands the application of flipped classroom in the field of motor skills and enriches the relevant literature of flipped classroom mode. Based on the findings of this study, we make the following recommendations: (1) teachers can use the way of video recording to display technical actions of motor skills, (2) students can use video feedback to communicate with the teacher about the learning of motor skills, and (3) flipped classroom needs to pay attention to the teaching interaction between teachers and students.

However, there are some limitations in this paper. First, we used a literature review to validate four potential influencing factors. We may need to consider additional factors depending on the viewpoint: students' learning autonomy and teachers' preferred teaching methods, for example. As a result, future studies can conduct factor analysis and validation from a variety of perspectives. Second, the questionnaire data in this paper comes from motor skills course student groups, and the sample size is small. Large sample studies should be conducted in the future, if conditions allow, to increase the universality of research findings. Finally, a motor skills class may differ from a typical social science or science class. As a result, the flipped classroom model's application effect in various courses may differ. As a result, interdisciplinary comparative research will be necessary in the future.

Data Availability

The data used to support the findings of this study are included within the article.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

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