



Application of Virtual Reality Program to Improve Individual Skills for Soccer Players

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Abstract

Background and Aim: This study takes the application of VR technology in soccer training as the research object and is expected to achieve the following research objectives: 1. To study the influence of VR technology on soccer heading and free kick and shooting accuracy of college soccer. 2. To compare the mean values between the experimental group and the control group. 3. To compare the mean values within the experimental group; pre-test, after the 3rd and 9th weeks.

Materials and Methods: This paper utilizes the literature method, experimental method, mathematical statistics method, questionnaire method, and scale measurement method to study the application of VR technology in soccer training. 48 sophomore students in the 2020 soccer option class of Nanchang University were randomly divided into the VR experimental group (22), and the control group (26). After a 9-week experimental study, we successfully completed the experimental procedures. The data obtained from the questionnaire survey and experiments were analyzed and interpreted in depth using the SPSS software package. Descriptive statistics, t-tests, and analysis of variance were mainly used to analyze the collected information. and drew the following conclusions through the statistics and analysis of the experimental results:

Results: 1. Soccer heading, free kick, and shooting accuracy were selected as the experimental indexes to test the personal technical ability of soccer players. In a comparison between the experimental and control groups, the VR experimental group showed highly significant differences in soccer heading, free kicks and shooting accuracy after 9 weeks of instructional training ($p < 0.001$). 2. The results of the paired t-test in the experimental group showed that: there was a highly significant difference between the pre and post-experimental comparisons of soccer heading, free kicks and shooting accuracy ($p < 0.001$). 3. The results of the questionnaire for the Emotional Interest in Sport Scale showed that: at the end of the experiment, the VR training group scored higher than the control group on all questionnaires with a highly significant difference ($p < 0.001$).

Conclusion: 1. The experimental group compared with the control group, individual soccer skills in the first phase of the traditional teaching after the progress of skill is not obvious; after the second phase of the VR technology teaching after the progress is very obvious, all three data show a highly significant difference. 2. Both the experimental data and the survey investigation data show that the improvement of self-confidence and the improvement of individual soccer skills in real-life performance of the students in the experimental group before and after the experiment are very obvious.

Keywords: Virtual Reality; Soccer; Individual skill

Introduction

Individual skills of Soccer refer to the general name of the athletes in the soccer competition rules conditions, the use of effective parts of the body to reasonably complete a variety of action methods. Soccer technology is the basic means and ability of athletes to carry out game activities, complete tactical cooperation, determine the premise, and guarantee the quality of tactics. Mainly includes: passing, receiving, shooting, dribbling over people, top ball, and so on. Zhong (2013) Traditional soccer teaching cannot meet the needs of students in today's society and cannot attract students' interest in soccer. In the current situation where the country is actively promoting information science education, the innovation of physical education teaching methods needs to be innovated.

The Ten-Year Development Plan for Education Informatization (2010-2020) issued by the Ministry of Education of China, is mentioned to promote education informatization, actively carry out applied research on digital teaching and learning, and continuously improve students' ability to learn on their own (Ministry of Education, 2012). VR technology is a virtual technology in reality that can provide students with an immersive experience. It has high application value in football teaching. Football technology is relatively complex, and students have difficulty in cognition and perception. It





is not easy for students to understand and master it. Through VR technology teaching, students can learn football skills through immersive experiences and understand the essentials of movements more intuitively and realistically. It can extend the boundaries of perception and simplify complex technologies.

As Virtual Reality (VR) technology continues to mature and VR headsets become more widely used in the consumer market, more and more people are using VR for gaming, entertainment, and skills training. In China, with some guiding documents coming out from the Ministry of Education, we are more determined to use digital technology for teaching and learning innovation. The Ministry of Education on the 2017-2020 exhibition in the national institutions of higher learning Notice on the Construction of Model Virtual Simulation Experimental Teaching Project (2017). However, Neumann et al. (2018) With the continuous development and advancement of digital technology, VR sometimes referred to as Virtual Environments (VE), the core concept of VR technology dates back to 1965. In recent years, VR technology has become increasingly popular with the advent of inexpensive consumer-grade VR headsets for gaming and entertainment. Nowadays, it can be seen that VR has been widely used in games and sports. Therefore, some studies focusing on the use of VR in sports are also increasing.

With the completion of the digital classroom of Nanchang University, VR technology can be used in football technical teaching. Our research has just begun. We refer to existing research literature at home and abroad to design and verify the impact of VR teaching on college students' football personal skills. From this study, it is concluded how to better apply VR technology in future teaching to improve college students' football skills.

Objectives

Main objective

To study the influence of VR technology on individual skills in college soccer.

Subsidiary objectives

1. To study the influence of VR technology on the soccer heading, free kick, and shooting accuracy of college soccer.
2. To compare the mean values between the experimental group and the control group.
3. To compare the mean values within the experimental group; pre-test, after the 3rd, and 9th weeks.

Literature Review

Localize

In China, VR technology is widely used in the fields of soccer, bed jumping, gymnastics, diving, and sailing. This shows that VR technology, with its advantages of low cost and zero risk, has a wide range of application prospects in various fields. The combination of VR technology and sports not only improves the training level of athletes but enhances athletes' sports performance.

Onyesolu & Eze (2011) found that a lot of advancements have been made using VR and VR technology. VR has cut across all facets of human manufacturing/business, exploration, defense, leisure activities, and medicine among others. The exciting field of VR has the potential to change our lives in many ways. There are many applications of VR presently and there will be many more in the future. Many VR applications have been developed for manufacturing, education, simulation, design evaluation, architectural walk-throughs, ergonomic studies, simulation of assembly sequences and maintenance tasks, assistance for the handicapped, study and treatment of phobias, entertainment, rapid prototyping, and much more. VR technology is now widely recognized as a breakthrough in the technological advance of science.

Song et al. (2018) concluded that VR virtual reality technology as an auxiliary tactical training equipment for juvenile soccer players has a significant improvement in tactical training, VR as a new means of technological assistance has been substantially verified, and its function and effectiveness have been recognized by athletes, coaches and project experts.

Liu (2015) through analysis, believes that the comprehensive application of VR technology and soccer teaching can, to a certain extent, improve the teaching mode, optimize the teaching method,

improve the quality of teaching, promote the diversification of teaching content, and reduce the sports injuries in soccer.

By summarizing the above literature, it is found that VR technology has been fully applied in the field of soccer and has demonstrated substantial research results. Especially the research on sports training has gradually become mature.

Globalize research

Foreign research on the application of VR technology in sports is earlier than domestic. The use of VR technology to train motor skills has been growing in popularity over the past decade.

Bliss et al. (1997) found that VR could be used to train firefighters equally as well on real-world spatial navigation as traditional methods and found that VR training improved performance on a real-world assembly task.

Kozak et al. (1993) found that there was no transfer of training from VR to the real world, in this case using a pick-and-place task. These conflicting results show that there is still more research that needs to be done on the transfer of training from VR to the real world.

Another study by Dessing and Craig (2010) examined how soccer goalkeepers capture curved free kicks in VR. They showed that elite goalkeepers waited much longer before starting to move, thus gaining more information about the trajectory of the ball, as they do in the real world.

VR allows safe and repeatable training tasks and affords complete control over the training environment including stimuli and difficulty (Wood et al., 2021). Therefore, it is considered a promising tool for skill acquisition and refinement in sports (Miles et al., 2012).

Anecdotaly, VR technology is already being used by approximately half of the English Premier League (football) clubs. to target specific cognitive skills, simulate matchday pressure and minimize the risk of head injuries during practice (Hart, 2018).

Conceptual Framework

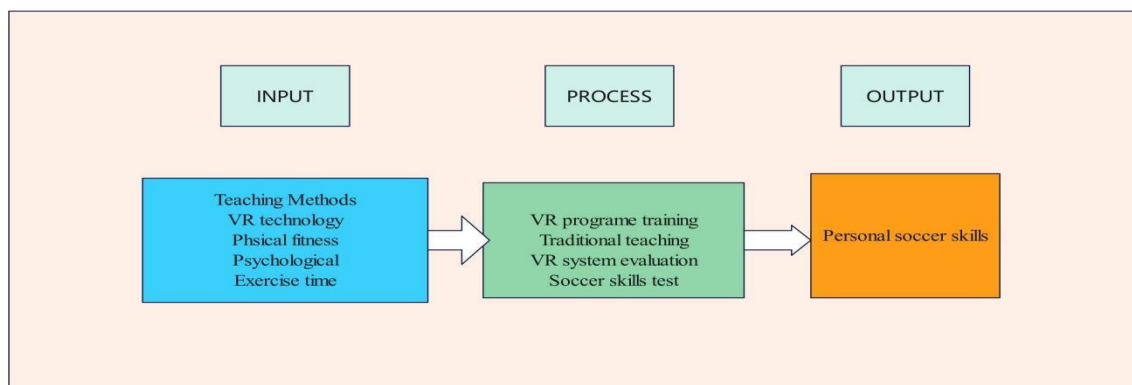


Figure 1 Conceptual Framework

Methodology

Research instrument

Research Site: The experimental group T2 Training in VR classrooms, Nanchang University set up VR classrooms in 2019 and began to use them in 2020. The control group T1 was trained in the playground and gymnasium of the normal PE class.

Population and sample

The population of this study came from 300 general football elective students in their sophomore year at Nanchang University. Using the convenience sampling method, we selected 60 sophomore students from them. Due to students' physical and personal wishes, the finalized sample consisted of 48 participants, 22 in the experimental group and 26 in the control group, with an average age of 19 years, all male university students.

Participants: The finalized sample consisted of 48 participants, 22 in the experimental group and 26 in the control group, with an average age of 19 years, all male university students.



Demographic questionnaire: The demographic questionnaire obtained information about the participants, including items including age, gender, football history, and previous VR experience.

The students participating in the experimental group age (19.09 ± 1.23) and all of them were male. The large total number of students just had one year of soccer learning experience in the university but did not systematically learn the three individual soccer skills of soccer heading, free kick, and shooting accuracy, so this experimental teaching was also considered novice for them. In terms of VR experience, through the survey, only 2 participants had experience of VR use, and 20 participants had never had experience of using VR equipment, accounting for 90.9% of the total.

Virtual reality headset displays (VR HMD) and applications:

VR HMD: HTC VIVE PRO 2.0 Head-mounted display (HMD) was used for the VR training of this experiment. The hardware is displayed at 120 Hz at a resolution of $2880 * 1600$ pixels per eye, with a field of view of 120° .

The VR program: Rezzil IDEX Lite system (Rezzil Europe, Manchester, UK) The application is used to provide VR football training. This application is simulated by Rezzil Expert VR, which is used to train professional players from clubs around the world.

The Rezzil Player 22 (Rezzil Europe, Manchester, UK) application was used to provide VR football heading training. This application consists of 60 heading training drills with high scores for consistency and accuracy allowing progress to further drills.

The current study followed similar procedures as those in Marshall et al. (2012) and Wood et al. (2021) Wood et al. (2021) Tested the construct validity of a soccer-specific virtual reality simulator using novice, academy, and professional soccer players, the result showed that the VR system differentiated between novice and academy players with a probability of 76%, between the academy and professional players with a probability of 85%, and between novice and professional players with a probability of 97%. In conclusion, these results demonstrate the construct validity of this soccer-specific VR simulator.

Therefore, in this study, we referred to the hardware head-mounted display devices and VR training programs commonly used by domestic and foreign scholars and conducted this teaching experiment.

Data collection: Data collection mainly includes two total scores: collection of survey data and collection of experimental data.

1. Collection of survey data

Employs a semi-structured interview approach to survey with 48 Experimental participants. obtain information about the participants, including items including age, gender, football history, and previous VR experience. Once an interview is concluded, researchers convert audio materials into text format for ease of organization and analysis in subsequent work.

2. Collection of experimental data

To study the influence of VR technology on individual skills in college soccer. We collect the experimental data, including pre-test, after the 3th, and 9th weeks. the testing items include soccer heading, free kick, and shooting accuracy. In each experimental test, researchers use tools such as paper forms to record the data of the testers and sign on-site to confirm the authenticity of the information. After the testing is completed, the researchers promptly convert the data into text format for statistical and analytical purposes in subsequent work.

Data Analysis: In this study, the collected questionnaire data and experimental data were analyzed and interpreted in depth using SPSS 26.0 and Microsoft Excel 2021. The demographic questionnaire obtained information about the participants, including items including age, gender, football history, and previous VR experience. the students participating in the experimental group were relatively close in age (19.09 ± 1.23) and all of them were male. The large total number of students just had one year of soccer learning experience at the university.

The experimental data were analyzed First, descriptive statistics were used to analyze the basic information of the experimental participants in the collected questionnaire samples and to describe the overall characteristics of the group. The differences between the two groups of experimental participants were revealed by calculating statistical indicators such as mean scores and T-tests.



Secondly, the data of experimental and control groups were analyzed by t-test independent and ANOVA repeated measure through SPSS 26.0 to reveal the significance of pre-tests and post-tests between the same groups and the significance of post-tests between different groups.

Research Process

Pre-test

Each participant who would be identified was first guided through the consent process, all participants completed several questionnaires that included questions about participant demographics (e.g., age, gender, soccer experience, and VR experience).

1. Collect the personal information of 48 students in the soccer option class and rationalize the grouping by combining it with the test of difference to ensure that there is no significant difference in all basic information between members of the two groups.

2. Verify the grouping according to the pre-test indicators

Collect the two groups of experimental subjects for the indicators of header, free kick, and easy accuracy, and carry out the difference test on them, if there is no significant difference, then verify that the grouping is reasonable.

3. Collecting other experimental data

First, each participant completed three header exercises, kicking accuracy exercises, and free kick exercises, and for the experimental group we simulated the exercises as close as possible to the environment in Brazil. Second, after completion of the exercises, 6 soccer heading tests, 6 free kick tests, and 6 shooting accuracy tests were performed, and the number of goals scored by the headers and the scores of each test was recorded.

Training

T2: VR T-group

Participants in the VR training group learned and trained in three programs according to the training plan we developed, which was divided into two phases. The first phase consisted of 3 weeks of traditional teaching and practicing at an outdoor soccer field, to understand and master the most basic soccer skills. The second phase consisted of 6 weeks of VR program using the Rezzil Player 22 app and the Rezzil Index Lite system in the VR classroom at SCU, 1 session for 2 weeks for each program. this has been previously shown to be an effective delivery method for improving the perceptual-cognitive skills of soccer players (Murgia et al. 2014). Time: Subjects conduct VR training once a week Each class lasts for 90 minutes, a total of 6 times.

T1: Traditional training group

Participants in the control group also learned and trained the 3 soccer skills for 9 weeks according to the training program we developed, and they all did so in the outdoor soccer field of Nanchang University, training for 3 weeks in each sport, with one session per week for 90 minutes.

Post-test

Participants again attended an individual session at an outdoor soccer field and were assessed for their perceived level of personal soccer skills, a survey of interest, and a survey of their confidence in completing the three program tasks. Participants then followed a pre-test procedure for three training sessions, followed by a formal soccer header, free kick, and accuracy shot test. The number of goals and points scored in each program were recorded.

The research process is shown below:

Research sequence map

- O1: pre-test (flow in class), T2(1-3): general soccer lesson,
T2(4-9): VR soccer lesson
T1(1-9): general soccer lesson
O2: post-test (flow in class)





Results

After 9 weeks of formal teaching experiments, we completed the experimental procedures, and drew the following conclusions through the statistics and analysis of the experimental results:

1. Compare the differences in mean values between the experimental and control groups at the end of the experiment.

We applied the results of the statistical method of independent samples t-test to analyze whether there is a significant difference in the means between the two groups. The results are shown in Table 1

Table 1 Table of post-test statistics for the experimental and control groups (n=48)

Group Soccer	Heading $\bar{X} \pm S.D.$	Free kick $\bar{X} \pm S.D.$	Shooting accuracy $\bar{X} \pm S.D.$
T2	8.09±1.998	29.09±6.81	19.95±3.258
T1	4.73±1.373	22.31±4.38	14.65±2.813
T	-6.875	-4.166	-6.05
P	0 0 0		

*p<.05 **p<.001

Table 1 shows the mean value of the T2 for soccer heading is (8.09±1.998). The mean value of the T1 is (4.73±1.373), $P=0<0.05$. The average score of free kicks in the experimental group was (29.09±6.81). The mean value of the free kick in the T2 is (22.31±4.38), $P=0<0.05$. The mean value of soccer shooting accuracy in the T2 is (19.95±3.258), while the mean value of the T1 is (14.65±2.813), $P=0<0.05$, all there is a highly significant difference.

2. Repeated measures analysis of variance (ANOVA) was applied to study the interaction between experimental and control groups.

Through a 9-week instructional experiment, which was tested at weeks 1 (pre-test), 3, and 9, we examined the effects of time and grouping on college students' soccer skills by statistically analyzing the measurement data using repeated-measures ANOVA. The results were 2, 3, and 4.

Table 2 Results of a repeated-measures ANOVA for the soccer heading(n=48)

Factor	Sum of squares	df	Mean square	F	p
Trial	136.09	2	68.045	63.893	<0.001
Trial * GRP	72.424	2	36.212	34.002	<0.001
groups	65.684	1	65.684	11.36	0.002
Residual	97.979	92	1.065		

*p<.05 **p<.001

As shown in Table, there was an effect of time on soccer heading scoring ($F=63.893$, $p<0.001$), grouping on heading scoring ($F=11.36$, $p=0.002<0.05$), and interaction between grouping and time ($F=34.002$, $p<0.001$). Suggests that both the VR program and time affect individual college students' heading skills.

Repeated measures analysis of variance was used to analyze the interactive effects of time and grouping on college students' free-kick skills. The results are shown in Table 3.

Table 3 Repeated Measures ANOVA Results for free kick(n=48)

Factor	Sum of squares	df	Mean square	F	p
Trial	643.38	2	321.69	69.325	<0.001
Trial * GRP	411.325	2	205.662	44.321	<0.001
groups	141.836	1	141.836	2.258	0.14
Residual	426.911	92	4.64		

*p<.05 **p<.001



As shown in Table 3, there was an effect of time on free kick scoring ($F=69.325$, $p<0.001$), the grouping did not affect soccer free kick scoring ($F=2.258$, $p=0.14>0.05$), and there was an interaction between grouping and time ($F=44.321$, $p<0.001$).

Repeated measures analysis of variance was used to analyze the interactive effects of time and grouping on college students' shooting accuracy skills. The results are shown in Table 4.

Table 4 Repeated Measures ANOVA Results for shooting accuracy($n=48$)

Factor	Sum of squares	df	Mean square	F	p
Trial	268.285	2	134.143	52.826	<0.001
Trial * GRP	126.757	2	63.379	24.959	<0.001
groups	263.868	1	263.868	10.116	0.003
Residual	233.618	92	2.539		

* $p<0.05$ ** $p<0.001$

As shown in Table 4, there was an effect of time on shooting accuracy scoring ($F=52.826$, $p<0.001$), grouping on shooting accuracy ($F=10.116$, $p<0.001$), and there was an interaction between grouping and time ($F=24.959$, $p<0.001$). This suggests that both VR programs and time affect college students' shooting accuracy skills.

3. Compare the mean values within the experimental group; pre-test, after the 3rd weeks, and 9th weeks.

Sample paired t-tests were used to analyze whether there were any significant differences in header, free-throw, and shooting accuracy among the different paired groups before, during the third week, and after the experimental group.

Table 5 T2 Paired t-test for group samples($n=22$)

Pairing	Test Subject	t	P
Pairing 1	Soccer Heading (Pre Vs Mid	-1.449	0.162
Pairing 2	Soccer Heading (MidVs Post)	-9.721	0
Pairing 3	Soccer Heading (Pre Vs Post)	-11.936	0
Pairing 4	Free kick (Pre Vs Mid)	-1.891	0.073
Pairing 5	Free kick (Mid Vs Post)	-7.559	0
Pairing 6	Free kick (Pre Vs Post)	-9.07	0
Pairing 7	Shooting accuracy (Pre Vs Mid)	-1.668	0.11
Pairing 8	Shooting accuracy (Mid Vs Post)	-8.446	0
Pairing 9	Shooting accuracy (Pre Vs post)	-8.799	0

* $p<0.05$ ** $p<0.001$

Table 5 showed that the paired t-test for the experimental group samples yielded the following results:

Firstly, a Comparison of soccer heading Pairings

In Pairing 1, ($P=0.162>0.05$), indicating that after three weeks of training, there was no effect on soccer heading scoring. pairing 2 ($P=0<0.001$), showed that after 6 weeks of VR program training had a highly significant effect on soccer heading scoring. Pairing 3, ($P=0<0.001$), in the soccer heading skill pairing, indicated that after 9 weeks of training in the VR program, there was a highly significant effect on soccer heading scoring.

Secondly, a Comparison of free-kick pairings

In pairing 7, ($P=0.11>0.05$), indicating that after three weeks of training, there was no effect on free kick scoring. Pairing 8, ($P=0<0.001$), indicating that after six weeks of training in the VR program had a significant effect on free kick scoring. Pairing 9, ($P=0<0.001$), in the Free Kick Skill Pairing, showed that after 9 weeks of training in the VR program, there was a highly significant effect on free kick scoring.

Lastly In the experimental group in the shooting accuracy skill pairing

In pairing 4, ($P=0.073>0.05$), indicating that after three weeks of training, there was no effect on the shooting accuracy score. Pairing 5, ($P=0<0.001$), in the shooting accuracy pairing, indicated that there was a highly significant effect on the kicking score after six weeks of training in the VR program. Pairing 6, ($P=0<0.001$), in the shooting accuracy Skill Pairing, indicated that there was a highly significant effect on the shooting accuracy Score after 9 weeks of training in the VR program.

Summary

In a comparison between the experimental and control groups, the VR experimental group showed highly significant differences in soccer heading, free kicks, and shooting accuracy after 9 weeks of instructional training ($p < 0.001$).

The results of the paired t-test in the experimental group showed that: there was a highly significant difference between the pre- and post-experimental comparisons of soccer heading, free kicks, and shooting accuracy ($p < 0.001$).

Discussion

After the 9 weeks of training, it indicates that the students' 6-week VR instruction in the VR classroom allowed the students to improve their performance very significantly, and it was easier to improve their soccer skills than traditional instruction. We can only explore potential reasons why virtual reality training may have these benefits in the context of some of the literature.

VR technology significantly improves soccer teaching efficiency and low training risk.

Many factors determine an athlete's soccer skill improvement, such as due to biomechanics, physiology psychology, and training, so it is difficult to improve a student's athletic performance. One of the most important points is to do a good job with the perception-action cycle of the athlete.

Due to students experiencing head success in VR, this may have impacted their improved perceptions of self-confidence and self-efficacy. These perceived improvements are associated with improved perceived control, which has also been linked to improved soccer skill performance (Wood et al., 2012).

Murgia et al. (2014) research has shown that home-based training interventions are effective for training perceptual-cognitive skills in soccer players.

Gray (2019) work has shown that the addition of haptic feedback aligned with the bat's contact location improves performance in virtual baseball hitting. Integrating similar techniques into this soccer header VR system may provide additional benefits for training.

VR technology Making soccer training more aspectual and safer.

This is because the complex environment can be simulated through VR technology, which breaks through the limitations of traditional sports programs in terms of stadiums, equipment, safety, etc. Soccer projects are confrontational more intense sports, very easy in the process of movement of unavoidable accidents, through the use of virtual reality technology, can be very effective in avoiding this type of sports training injuries, the use of virtual reality technology and equipment environment to simulate real soccer training, to avoid due the high degree of difficulty and the injury caused to the students

Le, et al. (2022) attempt to create more digital classrooms, which will ensure that more students can walk into VR classrooms, thus playing well to the strengths of VR as an intervention tool in this specific context-it allows for repetitive exercises that may not be safe in the real world.

VR improves self-confidence and self-efficacy

Functional improvements induced by motor learning during VR training can also increase participants' self-confidence and self-efficacy (Long et al, 2020), which are important predictors of superior athletic performance (Moritz et al. 2000; Woodman & Hardy, 2003). Increased self-confidence and self-efficacy through VR training can lead to greater motivation to participate and persist in virtual interventions (Holden & Dyar, 2002). Thus, VR training appears to have both behavioral benefits as well as benefits for athletes' affective and emotional states.

Individual characteristics of the participants can also affect the results of the experiment

In my current study, the experimental participants were not competitive soccer players, and in considering the application of VR programs to real-world training, Miles argued that VR may be most



valuable when used as a supplemental training device for those with inherent knowledge and experience in the sport (Miles et al., 2012). This is the biggest benefit of VR as a training tool, where students can apply proper approaches and soccer techniques in a realistic game environment.

Recommendation

Recommendations for Policy

Future research could expand on the current findings by considering the use of VR for other skill levels and training environments.

1. Schools should establish more VR classrooms to meet the different needs of more students. At present, Nanchang University is planning the first college to establish a smart classroom, shortly, more students in the VR classroom will become possible.

2. Establish a unified VR teaching operation manual, to plan the teacher and students' behavior in VR teaching. At present, VR teaching is still in its infancy, and the operations are not yet planned, which is easy to confuse.

3. Strengthen the publicity and training of physical education teachers in digital technology.

Recommendation for Further Research

1. Extended study time: In future research, we consider extending the experimental time to train different soccer skills, to gain a more comprehensive understanding of the impact of VR technology teaching on the individual soccer skills of college students, and to plan out the practice time to be spent on each skill, to guide the future physical education teaching.

2. This experiment examined the effects of VR training among sophomores at Nanchang University who had one year of soccer experience as the main focus, which is representative of one group and not generalizable. Our future studies should include more diverse populations, especially experienced elite athletes, and novices without any experience, as well as children.

3. The current study also did not examine the relationship between individual soccer skills embodied in VR and different real-world environments. For example, how experimental participants performed differently and how they were the same in different weather conditions and different intensities of play.

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