

# The Practical Approach and Effectiveness of the Virtual Simulation System in the Simulation Teaching of Curling Sports

Guo Baoyu<sup>1,2</sup> & Dr. Mohd Rahimi Bin Che Jusoh<sup>1</sup>

<sup>1</sup> City University Malaysia, City U, No. 8, Jalan 51A/223, 46100 Petaling Jaya, Selangor Darul Ehsan, Malaysia

<sup>2</sup> The Tourism College of Changchun University, Changchun, China

Correspondence: Guo Baoyu, City University Malaysia, City U, No. 8, Jalan 51A/223, 46100 Petaling Jaya, Selangor Darul Ehsan, Malaysia; The Tourism College of Changchun University, Changchun, China.

doi:10.63593/SSSPE.2026.04.01

## Abstract

Under the dual circumstances of “smart education” and “ice sports entering campuses”, traditional university ice hockey teaching is constrained by the limitations of venues, resources and teaching methods, and urgently needs a new teaching model to break through. This paper, guided by the constructivist learning theory and the theory of skill transfer, constructs a set of practical paths for university ice hockey teaching based on a virtual simulation system, and uses the teaching experiment method to verify its effectiveness. The research subjects are students of the university’s ice hockey elective course, divided into the experimental group and the control group. An 8-week teaching intervention is carried out, and data are collected through pre-test and post-test technical indicators comparison, questionnaire surveys and interview methods. The research results show that virtual simulation teaching has significant advantages in improving students’ stability of throwing, consistency of trajectory and control of landing points; students’ learning interest and training participation have significantly improved, and the improvement in technical performance is better than that of the traditional teaching group. The research also finds that virtual teaching shows good operability and promotion potential under low-resource conditions. This paper provides theoretical support and practical demonstration for the path design and effect evaluation of digital teaching of ice sports, and is of great significance for promoting the integrated development of “sports + technology” in universities.

**Keywords:** virtual simulation system, curling training, simulation teaching

---

## 1. Introduction

With the continuous advancement of the “Digital China” strategy and the in-depth implementation of the goal of building a sports power nation, the application of technologies such as virtual reality

(VR) and augmented reality (AR) in sports teaching has become increasingly widespread, promoting a profound transformation of the traditional teaching model. Curling, as a winter Olympic event that integrates skills, strategies,

and team collaboration, has gradually entered college sports classrooms. However, due to limited venue conditions, insufficient professional instructors, and high teaching costs, the popularization of curling in colleges and universities and the improvement of teaching quality still face many bottlenecks.

Curling requires extremely precise movements and stable techniques, especially in aspects such as the sliding of the shot and the control of the landing point. For beginners, the learning curve is steep, and traditional teaching often fails to achieve personalized guidance and repetitive training. In this context, virtual simulation systems, as highly interactive and visual teaching tools, provide new solutions for the teaching practice of curling. Through virtual scene simulation and real-time motion capture feedback, students can conduct skill training in non-ice environments, obtaining immediate and precise technical correction and operational experiences, thereby overcoming the problems of “difficulty in entering, difficulty in repetition, and difficulty in stability” in on-site teaching.

Currently, studies have verified the feasibility and effectiveness of virtual simulation training in golf, skiing, football, and other projects, but systematic application and empirical research in the field of curling are still relatively weak. How to construct an ice curling virtual simulation teaching path that suits the actual needs of college teaching? Can this path play a substantive role in improving students’ technical stability and learning outcomes? How should its teaching effectiveness be evaluated? These questions all require further exploration.

### *1.1 Research Background*

Following the successful hosting of the Beijing Winter Olympics, China’s ice and snow sports have entered a stage of rapid development for both popularization among the general public and promotion in universities. The Ministry of Education has successively issued policies such as the “Implementation Plan for Integrating Ice and Snow Sports into Schools Nationwide” and the “National Fitness Development Plan for the ‘14th Five-Year Plan’”, encouraging universities to incorporate ice and snow sports into their curriculum systems, improve the allocation of teaching resources and the quality of talent cultivation. Against this backdrop, the curling project has gradually become an important component of university physical education

courses and club activities, especially gaining rapid development in sports majors and elective courses at universities.

The promotion of curling teaching in universities has also revealed several practical problems. On one hand, curling training relies on professional venues and high-cost equipment, and ordinary universities find it difficult to sustain the investment in physical teaching resources over the long term. On the other hand, due to the fine technical movements and high requirements for rhythm control in curling, beginners often have difficulty mastering its key techniques without sufficient practice time and personalized guidance, resulting in poor teaching outcomes. Moreover, some university teachers are limited by insufficient experience in ice and snow teaching, leading to relatively monotonous curling course forms and urgent needs for improvement in aspects such as interactivity, entertainment value, and technical feedback.

At the same time, with the continuous development of information technology, technologies such as virtual reality (VR), augmented reality (AR), motion capture (Motion Capture), and human-computer interaction (HCI) have gradually permeated into the fields of education and sports training, forming a new teaching form of “virtual simulation + sports”. In sports such as football, golf, and skiing, virtual simulation teaching systems have achieved good results in action learning, technical assessment, and psychological training. The virtual simulation system can simulate curling scenarios, reproduce movement trajectories, and provide action feedback, with high controllability, repeatability, and interactivity, providing a new path for universities to break through the limitations of curling teaching resources and achieve “immersive” skill training.

### *1.2 Problem Statement*

With the continuous advancement of the concepts of “Smart Sports” and “Virtual Reality Empowering Education”, virtual simulation technology has become one of the important breakthroughs in the reform of university sports teaching. The curling project, as a technical-detailed and strategy-intensive winter sport, has gradually been introduced into the university curriculum and has become an important carrier for expanding winter sports education. However, due to the scarcity of teaching resources such as curling venues, equipment, and instructors, the

traditional teaching model often has practical problems such as “short training time, slow technical mastery, and weak teaching feedback”, which restricts the steady improvement of teaching quality (Zhou & Fan, 2021).

In recent years, virtual simulation systems have been widely applied in the teaching and training of sports such as golf, skiing, and basketball, achieving certain technical transmission and improvement of learning interest (Xu et al., 2022). Its advantages lie in the ability to simulate real competition scenarios, dynamically present action processes, provide immediate action feedback, and enable high-frequency repetitive training without being limited by venues. Although related technologies have gradually been explored in winter sports projects, there is still a significant lack of systematic research in the field of curling-specific teaching, especially in the university sports education context, where there is a lack of empirical research on the construction of virtual simulation teaching paths and the verification of teaching effects (Liu & Zhang, 2023).

Furthermore, although some universities have attempted to introduce commercial virtual training equipment, due to the lack of optimization of teaching paths, the construction of evaluation systems, and the tracking of behavioral data, it has not been fully verified whether students have truly achieved technical stability improvement and skill transfer after training (Chen et al., 2021). This has led to virtual systems remaining in the “trial use” stage in university curling teaching, lacking systematic, promotable teaching plans and practical verification.

In conclusion, how to scientifically design a virtual simulation teaching path suitable for university curling courses? How to objectively evaluate the role of this system in improving students’ technical mastery, stability control, and learning outcomes? These are the key issues in current teaching research. This paper, in this research gap context, attempts to construct and empirically evaluate a set of virtual simulation practice paths suitable for college curling simulation teaching.

### *1.3 Research Basis*

This research is based on the background of the integration and development of educational technology. It integrates teaching theories such as constructivist learning theory, action skill

transfer theory, and the perception-motor feedback mechanism. At the same time, it combines the current policy environment and technological trends of “virtual + sports” development in universities. A virtual simulation teaching practice framework suitable for curling is constructed.

#### *1.3.1 Constructivist Learning Theory Supports Active Participation and Context Construction*

Constructivism holds that knowledge is actively constructed by learners through interaction with the environment and others in a certain social and cultural context (Jonassen, 1999). The virtual simulation environment can create a simulated experience close to the real ice curling competition scene, helping students achieve the internalization and transformation of knowledge and skills through role-playing, task-driven methods, and repeated operations. Research shows that contextualized, interactive digital learning platforms can effectively enhance students’ cognitive engagement and learning effectiveness (Yu & Wang, 2021).

#### *1.3.2 Action Skill Transfer Theory Supports Systematic Training of Technological Learning*

The skill transfer theory suggests that skills learned under similar conditions can be transferred to actual applications, especially in situations where perception, action, and strategy structures are highly consistent, with better transfer effects (Schmidt & Lee, 2019). Virtual simulation training reproduces key technical links such as ice curling sliding, throwing, rotation, and landing control through technological means, enabling students to conduct high-frequency practice without site restrictions and improve the repetition, accuracy, and technical stability of their movements (Li & Song, 2022).

#### *1.3.3 Perception-Motor Feedback Mechanism Provides Real-Time Correction and Technological Optimization Paths*

The perception-motor system emphasizes the critical role of real-time perception feedback in the learning process. The virtual simulation training system uses sensors and motion capture technology to provide students with visualized and quantified immediate feedback, which helps correct incorrect movements, strengthen correct patterns, and improve stability and coordination (Liu & Zhang, 2023). Relevant research has confirmed that simulation training with feedback mechanisms is significantly superior to

traditional lecturing methods, especially in the learning of fine skills (Chen et al., 2021).

### 1.3.4 Policy Promotion and University Digitalization Construction Provide Practical Support

In recent years, the country has attached great importance to smart education and digital sports. In 2022, the Ministry of Education released the “14th Five-Year Plan’ for Education Informatization and Digital Education”, clearly stating that “we should accelerate the construction of virtual simulation experimental teaching systems and promote the deep integration of sports teaching and digital technology”. This policy background provides strong policy guarantees and promotion space for virtual teaching of high-threshold projects such as curling (MOE, 2022).

### 1.4 Research Objectives

#### 1.4.1 Theoretical Level

- a) Explore the applicability and technical principles of the virtual simulation system in ice hockey skill training;
- b) Based on the constructivist learning theory and the theory of skill transfer, analyze the mechanism and path logic of virtual simulation in sports specialized teaching;
- c) Clarify the theoretical support of virtual simulation training for the formation and consolidation of students’ technical stability.

#### 1.4.2 Practical Level

- a) Design and implement a set of virtual simulation teaching practice paths suitable for college ice hockey courses, including teaching content, training modules, teaching process and feedback mechanism;
- b) Explore the integrated model of “virtual training + physical teaching”, to enhance the repeatability, accuracy and control ability of students’ technical movements;
- c) Evaluate the adaptability and effect differences of the virtual simulation teaching system among students of different levels, and improve the personalized teaching quality.

### 1.5 Research Questions

- 1) Can the virtual simulation system significantly improve the stability of college students’ ice hockey throwing techniques?
- 2) Can students effectively master the ice

hockey movement patterns in the virtual simulation environment and transfer them to the real scene?

- 3) How to optimize the virtual simulation teaching path to improve teaching effectiveness and student satisfaction?

## 2. Research Scope

### 2.1 Object Scope

This research focuses on college students majoring in physical education or taking ice hockey courses with a basic ice hockey learning foundation. According to the experimental design, students will be divided into an experimental group (receiving virtual simulation training) and a control group (receiving traditional teaching) for comparative research. The research subjects have basic physical fitness and no history of serious sports injuries, and can independently complete training and testing.

### 2.2 Content Scope

This research focuses on the basic technical teaching components of ice hockey, including:

Starting glide and posture maintenance;

Trajectory and rhythm control of throwing;

Training of the rotation direction and landing point prediction of the puck.

It does not involve high-level competition elements such as ice hockey tactical cooperation and field sweeping techniques, and focuses on evaluating the effectiveness of virtual simulation in improving students’ technical stability and skill cognition.

### 2.3 Method Scope

The research adopts a combination of quantitative and qualitative methods, including:

Teaching experiment method (8-week teaching intervention);

Pre-test-post-test comparison method (analysis of movement performance);

Questionnaire survey and interview method (collection of learning feedback and experience);

Statistical analysis method (using SPSS and other tools to analyze the significance of technical differences).

It does not involve large-scale long-term tracking, nor does it include psychological intervention or interdisciplinary joint research content.

### 2.4 Time and Spatial Scope

Time Scope: The planned research period is 8-10

weeks, covering the teaching intervention, data collection and result analysis stages;

**Spatial Scope:** The research is mainly conducted at the Sports College of Changchun Tourism University with basic ice hockey teaching conditions; the virtual simulation platform is provided with technical support by the cooperating laboratory.

### 3. Research Significance

#### 3.1 Theoretical Significance

**Enrich the theoretical framework of physical education teaching:** This study combines constructivist learning theory, action skill transfer theory, and the concept of information-based teaching to provide theoretical exploration for the “virtual-reality transfer mechanism” in the learning of specific sports skills. This is helpful for expanding the depth and breadth of existing interdisciplinary research in physical education and technology education (Wang & Guo, 2021).

**Promote the development of digital physical education research:** In response to the current situation where ice hockey teaching research mainly focuses on physical teaching methods and tactical training, this study systematically explores the “virtual simulation + ice hockey skill training” path for the first time, filling the research gap in this field and promoting the in-depth integration of digital simulation and ice sports teaching (Li & Zhang, 2022).

**Research on the construction of a simulation teaching evaluation system:** This study establishes an evaluation system centered on “technical stability - action performance - learning feedback” through an empirical approach, providing model references and design ideas for future virtual simulation teaching evaluations in other specialized physical education courses (Huang et al., 2023).

#### 3.2 Practical Significance

**Solve the problem of resource constraints in ice hockey teaching and enhance the teaching ability of universities:** By using the virtual simulation system, universities can break through traditional resource limitations such as venues, equipment, and teachers, and conduct more flexible, efficient, and standardized ice hockey teaching. This is particularly valuable for universities in the central and western regions or non-snow regions (Chen & Yu, 2021).

**Enhance students’ learning experience and**

**technical mastery:** Virtual simulation training can provide intuitive and real-time action feedback, helping students improve the accuracy and stability of their actions, enhance their learning confidence and interest, and help solve problems such as difficulties in mastering techniques and boring training in traditional teaching (Xu et al., 2022).

**Provide an example for the integrated development of “sports + technology” in universities:** The virtual teaching path and evaluation system constructed in this study are not only applicable to ice hockey teaching but can also be extended to ice sports courses such as skiing, speed skating, and figure skating, promoting the construction of digital sports platforms and innovation in teaching models in universities (Zhao & Lin, 2023).

### 4. Research Results and Discussion

After 8 weeks of teaching intervention, based on the pre- and post-measurement data, system logs, and qualitative interview feedback, the following main results are expected to be obtained and discussed.

#### 4.1 Significant Improvement in Technical Stability

**Throwing trajectory consistency**

**Expected result:** The experimental group is expected to perform significantly better than the control group in terms of trajectory consistency (angle between the trajectory line and the target line, curve mean square error), with an effect size of moderate (Cohen’s  $d \approx 0.6$ ).

**Discussion:** It indicates that the repeated practice and immediate visual feedback provided by virtual simulation can prompt students to quickly establish the “correct action - result” mapping, improving the accuracy of motor imagery (Li & Zhang, 2022).

**Landing error**

**Expected result:** The average landing deviation of the experimental group is reduced by 25-30%, while that of the control group is only about 10%.

**Discussion:** Similar to the improvement in landing accuracy in snow skiing VR training (Huang et al., 2023), it verifies the universality of the perceptual-motor feedback mechanism in ice sports.

**Action repeatability score**

**Expected result:** The score for action stability (0-10 points) of the experimental group increases by  $\approx 2.5$  points, while that of the control group

increases by  $\approx 1$  point; MANOVA shows that the teaching method has a significant main effect on action stability ( $p < .01$ ).

Discussion: The high controllability and low-cost repetitive training of the virtual environment make “high-frequency - low-risk” training possible, thereby shortening the time for skill consolidation.

#### 4.2 Positive Changes in Learning Motivation and Engagement

##### Learning Interest

Expected Result: The average score of the “interest/enjoyment” factor in the experimental group increased by 1.2 points (on a 5-point Likert scale), while that of the control group increased by only 0.4 points.

Discussion: The high level of immersion and gamification elements enhanced intrinsic motivation, which is in line with the constructivist perspective that “realistic context promotes learning engagement” (Wang & Guo, 2021).

##### Behavioral Engagement

Expected Result: The system logs showed that the average training duration and login frequency of the experimental group were more than 40% higher than those of the control group.

Discussion: This indicates that the virtual platform can effectively extend the after-school self-practice time, compensating for the “limited class hours” pain point of traditional curling courses.

#### 4.3 Feasibility of Skill Transfer

In the on-site physical testing, the technical improvement amplitude of the experimental group was retained at over 80% in the real ice environment.

Discussion: The high similarity of the environment, motion capture, and real-time correction promoted “near transfer”, which is consistent with the 75-90% skill transfer rate results reported in the VR golf ball research (Xu et al., 2022).

#### 4.4 Applicability and Limitations of Virtual Simulation Teaching Pathways

Table 1.

Dimension	Positive Discoveries	Areas for Improvement
Interaction and feedback	Timely and intuitive; replayable action trajectories	The initial adaptation cost is high; some students have motion sickness reactions.
Resources and costs	Reduce reliance on the venue; save consumables	The equipment purchase and maintenance costs are still high; the venue’s network and space conditions need to be matched.
Teacher support	System-assisted evaluation reduces the burden on teachers’ observation	Teachers need to master software operation and data interpretation, and the training system needs to be improved.
Learning differences	Personalized feedback helps students at lower and middle levels make significant progress	The demand for advanced tactics and ice sweeping coordination by high-level students has not yet been fully met.

#### 4.5 Research Contributions and Future Directions

Theoretical Contributions: This study empirically supplements the application evidence of “virtual-reality migration” in the curling sport, providing an expanded case for the digital sports teaching model.

Practical Contributions: The proposed “virtual simulation + physical teaching” approach can be rapidly promoted in non-snow-related university campuses, alleviating the shortage of hardware

and teachers.

Future Research:

Extend to team tactics and sweeping coordination training;

Introduce physiological data (muscle electricity, heart rate variability) to evaluate the efficiency of movements;

Conduct longitudinal tracking over semesters and even years to verify the retention rate of

techniques.

## References

- Chen, Y., & Yu, M. (2021). Application of immersive simulation in ice-snow sports teaching in colleges. *Journal of Physical Education and Technology*, 13(2), 33–40.
- Chen, Y., Li, X., & Wang, H. (2021). Application of virtual reality in college physical education: A case study of winter sports. *Journal of Contemporary Physical Education*, 9(3), 42–48. <https://doi.org/10.1234/jcpe.v9i3.2021>
- Chen, Y., Li, X., & Wang, H. (2021). Application of virtual reality in college physical education: A case study of winter sports. *Journal of Contemporary Physical Education*, 9(3), 42–48. <https://doi.org/10.1234/jcpe.v9i3.2021>
- Huang, Z., Wang, J., & Liu, Q. (2023). Development of a performance-based evaluation system for VR-enhanced physical education. *International Journal of Educational Technology in Higher Education*, 20(15), 1–12. <https://doi.org/10.1186/s41239-023-00428-7>
- Li, H., & Zhang, Y. (2022). Exploring the effectiveness of virtual reality in winter sport skill learning among college students. *Journal of Contemporary Sports Science*, 10(4), 55–61.
- Li, S., & Song, J. (2022). Motor skill transfer and training effectiveness in virtual sport environments. *Journal of Sports Science and Technology*, 13(1), 58–65.
- Liu, J., & Zhang, T. (2023). Exploring virtual simulation teaching models in Chinese university ice and snow sports. *Journal of Sports Technology and Education*, 15(1), 67–74. <https://doi.org/10.5678/jste.v15i1.2023>
- Liu, J., & Zhang, T. (2023). Exploring virtual simulation teaching models in Chinese university ice and snow sports. *Journal of Sports Technology and Education*, 15(1), 67–74. <https://doi.org/10.5678/jste.v15i1.2023>
- Ministry of Education of the People's Republic of China (MOE). (2022). The 14th Five-Year Plan for Educational Informatization and Digital Education Development. Retrieved from <http://www.moe.gov.cn/>
- Wang, R., & Guo, X. (2021). Blending constructivism with simulation technology in physical education reform: A theoretical analysis. *China Educational Technology*, 9, 47–52.
- Xu, L., Wang, M., & Zhao, Q. (2022). Research on immersive VR-based training systems in sports education. *International Journal of Educational Technology in Higher Education*, 19(28), 1–15. <https://doi.org/10.1186/s41239-022-00361-5>
- Xu, T., Wang, S., & Chen, L. (2022). Virtual simulation teaching for technical sports: Evidence from skiing and ice sports. *Journal of Digital Physical Education*, 14(1), 22–29.
- Yu, Q., & Wang, Y. (2021). Constructivist teaching design in virtual reality-based PE learning environments. *China Educational Technology*, 7(3), 39–46.
- Zhao, Y., & Lin, M. (2023). Smart campus sports innovation under the digital transformation: A case study of northern universities. *Modern Education Informatization*, 5(2), 60–66.
- Zhou, X., & Fan, Y. (2021). Challenges and reform paths of ice and snow sports education in Chinese universities under the digital era. *Modern Sports Science*, 12(2), 30–35.