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Research Article

Innovative Virtual Reality Training Schedule for Cricket Batting Skill Enhancement: Design, Validation, and Implementation

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ABSTRACT

The goal of the study is to design and validate of virtual reality training schedule that will help cricket batsmen become more proficient at batting. In addition to reviewing the relevant literature on virtual reality training that develops and examines the player's skills, techniques, and decision-making abilities in various sports, the Virtual Reality Training Schedule (VRTS) aims to utilize the capabilities of virtual reality technology to provide an immersive and interactive training environment, allowing batsmen to practice and refine their batting techniques, decision-making abilities, and adaptability to diverse match scenarios. With the aid of tables and charts, the paper explains the process of designing and validating the virtual reality training schedule by adhering to important guidelines and professional recommendations. The paper highlights a well-designed Virtual reality training schedule that addresses the needs of the batsmen for cricket batting skill development. The study comes to the conclusion that the Virtual Reality Training Schedule has effectively met the urgent need for cutting-edge training techniques in the improvement of cricket batting skills. The use of virtual reality technology in training design has created new opportunities to improve batting abilities and overall performance. The research was conducted on an intentionally selected 20 male right-handed cricket batsmen aged 16–19 years old who were recruited from the Under-19 Interstate Championship, Punjab, India. The study assesses the overall cricket batting ability through a virtual reality training schedule in two different parts: a Virtual reality training schedule design and validation through experts and another part practical implementation to assess the training schedule's effect on selected batsmen's batting skill. For the VR training, the Researcher used the IB Cricket companion software where batsmen enhance their individual skills by wearing an Oculus Quest Advance 2.0 device which is a hardware companion ware run. (VRTG) participated in 12 practice sessions that were conducted over 4 weeks, each week 3 sessions, and each session was 35 Min for every Batsman. The results showed that the virtual reality training schedule significantly improved the batting skill ability of virtual reality training group (VRTG) batsmen. Specifically, for selected batting ability, there was a notably higher training

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load when playing in the regular environment compared to VR. Based on these findings, we recommend using the virtual environment to train effectively for batting skills enhancement. For performance-level players, VR is a suitable training tool in terms of muscle activation and batting skill enhancement.

KEYWORDS: Validation, Design, VRTS, Batting Skill, Cricket Batsmen, Virtual Reality, Cricket, Machine Learning.

INTRODUCTION

Virtual Reality (VR) has emerged as a promising tool in the field of sports training, offering immersive and interactive environments to simulate real-world scenarios. Ahir, K. 2020 explains that VRT can be beneficial for psychological training, tactical skill development, training objectives, and technical stimulators to improve training strategy. Cricket, often referred to as a game of strategy and skill, encompasses various facets that contribute to a team's success. Among these, batting stands as a crucial component, capable of shaping the outcome of a match. Padli, P. 2023 revealed this tool is used by using the sensor from the camera to see how fast the shots are going in the game of cricket. In cricket, the application of VR technology has the potential to revolutionize training methods, allowing batsmen to practice against diverse bowlers, deliveries, and match situations without the constraints of time, weather, or physical fatigue. Kelly, N. 2022 suggests the batting simulator in virtual reality (VR) gives the batter access to bowler run-ups and allows real players to virtually improve their batting technique

The proposed VR training schedule incorporates cutting-edge technology to simulate diverse game situations, allowing batsmen to practice against virtual bowlers in realistic cricket environments. Nambi, G. 2020 explores Virtual Reality Training is used widely because contributes to the prevention of further injuries.

A comprehensive validation process ensures that the VR training effectively mirrors the dynamics of actual gameplay, providing a reliable platform for skill development. Through the VR training system, the athletes can get better training effects suggests Zhao, K. & Guo, X. 2022.

This implementation is complemented by a user-friendly interface, allowing coaches and players to customize training sessions based on individual skill levels, strengths, and weaknesses. Emre Gurbus and Murat Tas, 2023 evaluated the effectiveness of virtual reality training in 12–13-year-old child football players and improved the heading technical skills of child football players by using virtual reality technology without experiencing any injuries due to heading at a young age in the future.

Hawkar Oagaz, Breawn Schoun, and Min-Hyung Choi, 2021 VR skill acquisition and training transfer by using a system that combines realistic audiovisual stimuli and real-time feedback, supports the validity of VR for training and provides a low-cost, accessible, timesaving, and effective system for table tennis training in VR. Matthew Buns, 2020 addressed how virtual training can improve the accuracy and velocity of real-world hockey shooting on goal in isolated practice settings, it remains unknown whether such skills would be effectively applied during actual gameplay. Brad Thatcher, Georgi Ivanov, Mihaly Szerovay, and Graham Mills, 2020 analyzed elite coaches' and performance analysts' perceptions of barriers and opportunities for the adaptation of VR technology in football coaching. Rob Gray, 2017 examined the real value of using VE as a training tool for sports, not the ability to create more repetitions of the same types of practice that are used in real training.

The presented VR training schedule signifies a paradigm shift in cricket coaching methodologies, providing an immersive and engaging platform for skill enhancement. Aishwar Dhawan, Alan Cummins, and Wayne Spratford, 2016 describe illustrates a novel immersive, interactive VR bowling simulator that may be used to assess expertise in cricket batting. This paper contributes to the growing

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body of research in sports technology, demonstrating the potential of VR in revolutionizing the way cricket batting skills are developed and refined. As the cricketing landscape evolves, embracing innovative technologies like VR can pave the way for a new era of precision and mastery in the sport.

METHOD

The utilization of VR technology is directly dependent on the complexity of the interaction between the user(s) and the environment system. During this study, the researcher used the Oculus Quest advanced 2.0 device to create a 3D virtual reality environment. In this device, ib Cricket companion software was run for cricket simulation in which many models are available for the enhancement of batting skills. So, the researcher created a Virtual Reality Training Schedule by using virtual reality and machine learning to enhance the batting skills of cricket batsmen. This design was made specifically for right-handed batsmen, in which Batsmen were trained through virtual reality for 16 weeks, three sessions each week, and 35 minutes total for each session. The study was done through face validity and expert suggestions for the construction of the virtual reality training design for improving cricket batting skills.

Equipment: Virtual Reality Headset, Controller, iB Cricket Companion Software, Streaming Software, HP Laptop, Bat, Batting Glove, Batting Pad, Helmet, Abdo Guard and Net Area.

Participants: The participants in the study were 20 male right-handed cricket batsmen aged 16–19 years old who were recruited from the Under-19 Interstate Championship, Punjab, India. Only participants in this study secured medals (Position) at the Inter-state and State Levels. The sampling frame that was used for this study was self-selected and made only one Virtual Reality Training Group. Before group assignments, Batsmen whose association had expressed interest in taking part in the study were screened to confirm that they were willing to participate, once they were informed regarding the study requirements and checked against the inclusion and exclusion criteria. Inclusion criteria were: aged 16-19 years at the beginning of the study, able to use VR cricket simulation, able to attend all the training sessions of the intervention program, and have knowledge of cricket. Exclusion criterion was a current clinically severe health problem or disorder making it not possible to perform the intervention program. Then, the association of the batsmen was asked for a written informed consent statement that the batsmen could participate in the research.

Virtual Reality Training Schedule: This study is divided into two parts. In one part the Virtual reality training schedule has been designed and validated. and in the other part, the practical implementation of Virtual reality training design has been done.

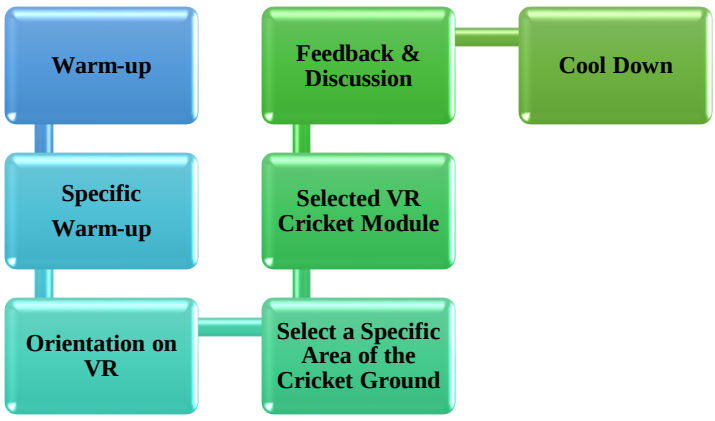

Figure 1 Design/Steps Formation of the Virtual Reality Training Schedule.

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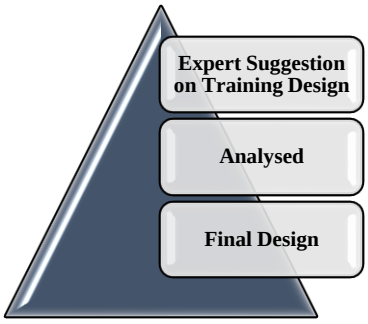

Figure 2 Validation Steps of the Virtual Reality Training Schedule.

Steps of Design:

Step-1 Warm-up:

Light Jogging: Begin with a 5-minute light jog around the field. This helps increase your heart rate and gradually raises your body temperature. After this General Stretching Exercises will be performed for 5 minutes.

Head to Toe:

- Neck Side-to-Side Stretch: The neck side-to-side stretch will be a simple yet effective warm-up exercise to help relieve tension and increase mobility in your neck muscles.
- Overhead Arms Pull: Overhead Arms Pull will help stretch and prepare your upper body muscles, including the shoulders and chest.
- Abdominal Stretch: Abdominal Stretch will help engage and prepare your core muscles for various activities. It's a straightforward way to enhance the flexibility and warmth in your abdominal area.
- Quadriceps Stretch: Quadriceps Stretch that focuses on the front thigh muscles (quadriceps). It will help improve the flexibility of your quadriceps and prepare your legs for various physical activities.
- Ankle On the Knee Stretch: Ankle on the Knee Stretch focuses on stretching and warming up the muscles around your hips and thighs. This stretch will help improve hip flexibility and prepare batsmen's lower bodies for various physical activities.

Step-2 Specific Warm-up:

5 Minute Specific Warm-up with the bat:

- Stance for Batting Drills: The stance for batting in cricket is a fundamental aspect of a player's technique. A proper batting stance provides balance, control, and the ability to execute various shots effectively.
- Back Foot Movement Drills: Back foot movement drills in cricket are essential for batsmen to master the art of playing balls that are pitched short or directed toward the body. These drills help improve a batsman's footwork, balance, and ability to play short-pitched deliveries effectively.
- Front Foot Movement Drills: Front foot movement drills in cricket are essential for batsmen to develop proper footwork and technique when facing deliveries that are pitched full or on a good length. These drills help to improve the batsman's ability to get into a strong position to play these deliveries effectively.
- Head Movement Drills: Head movement is a critical aspect of batting in cricket. Proper head positioning allows batsmen to maintain balance, focus on the ball, and execute shots effectively.

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- Shadow Batting Drills: Shadow batting drills in cricket are an excellent way to work on your technique, footwork, and shot selection without the need for a bowler or a cricket ball. These drills allow you to practice and refine your batting skills on your own.

Step-3 Orientation on VR:

Batsmen can become familiar with the VR training environment by following this orientation guide in just 5 minutes, and they will feel more confident and comfortable utilizing it for training.

Components of a VR Setup:

- VR Headset: This is the primary hardware component and is worn over the eyes like a pair of goggles. It displays the virtual world to the user and often includes built-in sensors for tracking head movements.
- Controllers: Hand-held devices that allow users to interact with the virtual environment. Controllers can have buttons, triggers, and motion sensors for precise tracking of hand movements.
- Sensors: External sensors or cameras may be used to track the position and movement of the headset and controllers, enhancing the sense of immersion.
- Computer or Console: A powerful computer or gaming console is usually required to run VR applications and generate high-quality graphics and experiences.
- Software: ib Cricket and stream, often available through platforms like Steam VR are essential for casting the live streaming.

Figure 4 Interface of ib Cricket Companion

Figure 3 VR Setup

Step-4 Select a Specific Area of the Cricket Ground:

Selecting a specific area of the cricket ground to hit a shot depends on various factors, including the field placements, the type of shot you intend to play, and your skill level. Here are a few common areas on the cricket ground where you might target your shots: Mid-Off, Cover, Backward Point, Third Man, Wide mid-on, Deep Mid-Wicket, and backward Square Leg. Remember that shot selection is a crucial aspect of batting in cricket. It depends on your strengths, the match situation, and the bowler you are facing. Adapt your shot selection based on these factors to maximize your chances of success on the cricket field.

Step-5 Selected VR Cricket Module: To improve their batting through the virtual reality training module, the batsmen will use this section of ib Cricket companion in which batsmen will participate in virtual reality training. This training will last for just 10 minutes in which batsmen select Caching and Practice module options.

Coaching and Practice: Cricket is an extremely complex sport on many levels; thus, players must learn specific technical skills with the help of trainers. A typical skill training that takes up a lot of training time is correcting the batsmen's errors, keeping this problem in mind, ib Cricket Companion has been created. With the aid of ib cricket, the batsman will start his training program, which includes practicing in various roles and disciplines as well as under simulated game conditions, depending on his demands. The batsman can choose from a range of practice options here. This module has been divided into three sections, which are shown as follows.

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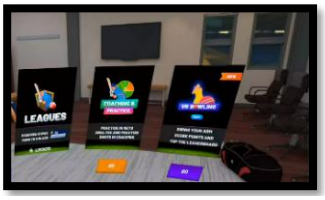

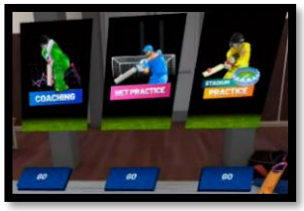

Figure 6 Coaching and Practicing Arena

Figure 5 Various Practice Zone

(A) Coaching: The iB Cricket coaching module tools look at the target batter and assess their ability to hit the shot in all directions on the cricket ground.

Figure 8 Coaching Module

Figure 7 Coaching Analyses

Figure 9 Coaching Analyses

(B) Net Practice: Practice on the net is essential in cricket. By applying their skills more frequently, batsmen improve their abilities. Batsmen advance their skills by continuously refining their techniques in the iB cricket net practice environment.

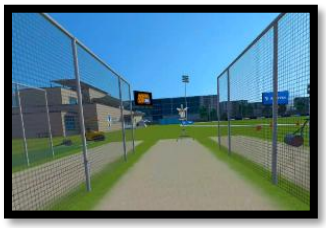

Figure 10 Net Practice

(C) Stadium Practice: Regarding the stadium practice features of iB cricket, it is also possible to forecast how consistently batsmen will perform under pressure. However, by often using this option, the player can maintain self-control.

Figure 12 Set-up Fielding Position

Figure 11 Stadium Practice

Step-6 Feedback and Discussion:

Feedback and discussion sessions, including doubt sessions and boost-up sessions, are crucial aspects of a cricketer's development. These sessions help players improve their skills, address weaknesses, and build confidence.

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Step-7 Cool Down Exercises:

- Neck Stretch: Stretching the neck is important for cricket players to help relieve tension, maintain flexibility, and reduce the risk of neck strain.
- Shoulders Stretch: Shoulder stretches are particularly important for cricket players, as they help to release tension in the shoulder muscles, improve flexibility, and reduce the risk of injury.
- Child's Pose Stretch: Child's Pose, known as "Balasana" in yoga, is a relaxing and gentle stretch that primarily targets the lower back, hips, and thighs.
- Standing Forward Band: The "Standing Forward Bend," also known as "Uttanasana" in yoga, is a simple yet effective stretch that primarily targets the hamstrings and lower back.
- Seated Forward Band: Seated forward bend (also known as Paschimottanasana) is a great cool-down exercise for cricket players as it helps stretch the gastrocnemius, spine, and improve overall flexibility.

Step for Validation:

Step-1 Expert Suggestion on Training Design

To evaluate the quality and impact of the Virtual Reality Training Schedule, expert suggestions hold significant value. These experts, owing to their profound knowledge, extensive expertise, and substantial experience, are uniquely positioned to conduct objective and subjective assessments of various facets of VR training programs. Their assessments not only serve as critical benchmarks but also serve as indispensable drivers for the refinement and advancement of VR training schedules tailored to cricket coaching. In pursuit of this evaluation, a carefully selected sample of 18 Cricket and Virtual Reality experts, representing diverse academic backgrounds from universities in India and various other countries, was engaged in this comprehensive study. This approach ensures valuable insights for refining VR training in cricket coaching.

Sr. No.	Name	Designation	Official Address
1.	Prof. Renato Sobral Monteiro- Junior	**Professor**	State University of Montes Claros, Vila Mauriceia, Montes Claros, Brazil
2.	Prof. Gabor Barton	**Professor**	Liverpool John Moores University, United Kingdom
3.	Sh. Naveen Sharma	**Retired Chief Coach (Cricket)**	Netaji Subhas National Institute of Sports, Patiala, Punjab
4.	Mr. Harpal Singh	**Assistant Coach (Cricket)**	Gwalior District Cricket Association, Gwalior, Madhya Pradesh
5.	Sh. Sanjay Mahajan	**Senior Coach, (Cricket)**	Patiala District Cricket Association, Patiala, Punjab
6.	Mr. Amanjot Singh	**Senior Coach, (Cricket)**	Jalandhar District Cricket Association, Jalandhar, Punjab
7.	Mr. Gurdeep Singh	**Head Coach (Cricket)**	Punjab Armed Police Cricket Academy, Jalandhar, Punjab
8.	Dr. Ranjeet Singh	**Coach (Cricket)**	Guru Nanak Dev Cricket Academy, Guru Nanak Dev University, Amritsar

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9.	Dr. Deepak Kumar Dogra	**Assistant Professor**	Banaras Hindu University, Varanasi, Uttar Pradesh
10.	Mr. Amit Dixit	**Senior Coach (Cricket)**	Lakshmi Bai National Institute of Physical Education, Gwalior, Madhya Pradesh
11.	Prof. Syed Tariq Murtaza	**Professor**	Aligarh Muslim University, Aligarh, Uttar Pradesh
12.	Dr. Sandeep Kumar	**Associate Professor**	Ch. Charan Singh University, Meerut
13.	Mr. Girish Bhanot	**Coach (Cricket)**	Punjab University, Chandigarh
14.	Mohd Ahmad	**Head Coach (Cricket)**	AMU Cricket Club, Aligarh Muslim University, Aligarh, Uttar Pradesh
15.	Mr. Pawan Panday	**Coach (Cricket)**	Lovely Professional University, Phagwara, Punjab
16.	Mr. Pankaj Choudhary	**Coach (Cricket)**	Cricket Coach, Shamli, Uttar Pradesh
17.	Mr. Devendra Arora	**Senior Coach, (Cricket)**	Harbhajan Singh Institute of Cricket, Jalandhar, Punjab
18.	Mr. Vikram Singh	**Coach (Cricket)**	Punjab Armed Police Cricket Academy, Jalandhar, Punjab

Table 1 List of experts for face validity

Step-2 Analysed

The expert evaluations of each item were analyzed using descriptive statistics. The level of agreement among the experts was computed for every query using face validity. To find any common themes or problems pertaining to the face validity of the Items, the written comments were also examined. The ultimate expert suggestion is visually depicted through the utilization of a table provided below.

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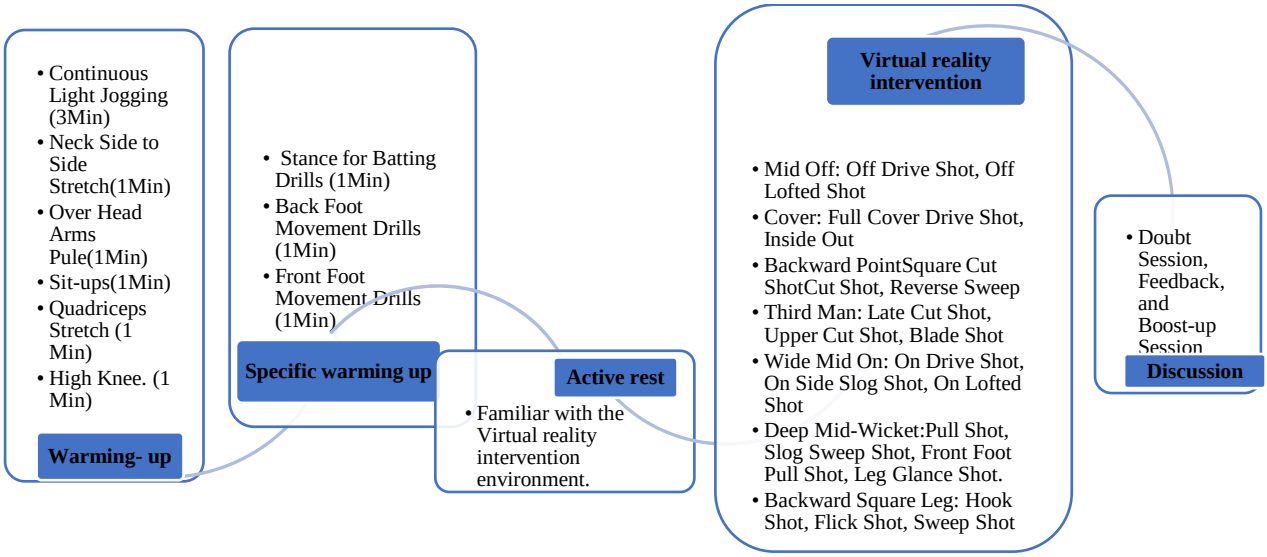

Figure 13 Proposed Virtual Reality Training Design

Activity	Follow-Ups
Warm-up	Abdominal Stretch, Ankle on the Knee
Specific Warm-up	Head Movement Drills, Shadow Batting Drills
Active Rest	Convert to Orientation on VR
Cricket Field Area & Shot	Each Field area per one Shot
Cool Down	Need to add Cool-down Exercise
Duration of VR training design	Duration explains specifically minute-to-minute
Selected Shots	Exclusively Grounded Shot.

Table 2 Follow-ups on Expert Suggestions

Step-3 Final Design:

The results of the expert opinions and face validity assessment provided valuable insights into the design development process for virtual reality training. They also emphasized the need to include clear training outcomes and objectives to guide the training and learning process effectively, as per the feedback of experts Warm-up Exercises, Area of Ground, Cricket Shots, Virtual Reality Intervention Time, and Cool Down Exercises are the most valuable suggestion for the design development of virtual reality. Details are given below in the flow chart.

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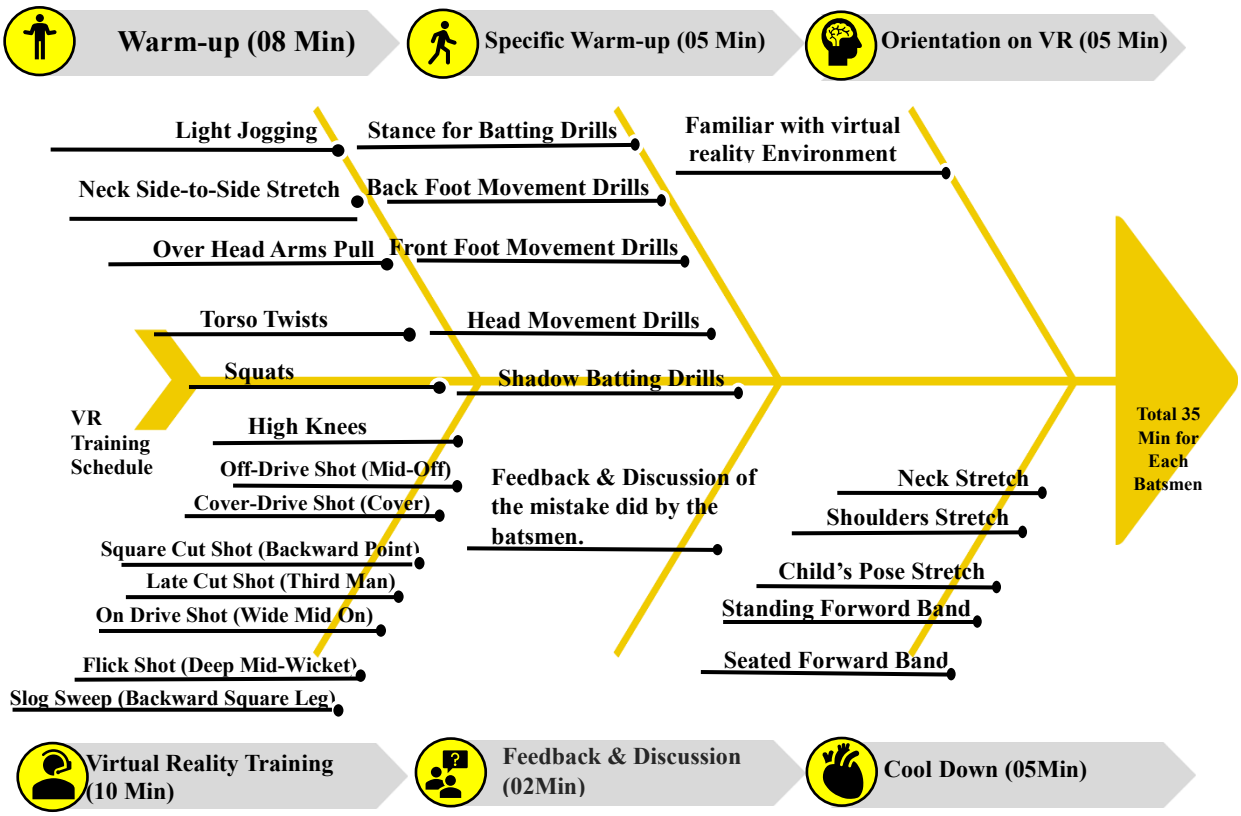

Figure 14 Final Virtual Reality Training Schedule

Procedure: After collecting the written consent, a pre–test was conducted in which batsmen assessed their batting skill ability through a Batting skill test (Developed by the Cricket Australia Centre of Excellence (COE), 2010). Then, the researcher randomly created a group VRTG for this study. Participants of the Virtual reality training group (VRTG) participated in 12 practice sessions that were conducted over 4 weeks, each week 3 sessions, and each session was 35 Min for Each Batsman. In which the batsmen were trained through IB cricket competition software by running the Oculus Quest 2 Advance VR device in fully immersive virtual environments. After the intervention, a post–test was conducted to assess the virtual reality training effect on the batting skill of the batsmen. The overall study design is conferred in Figure 15.

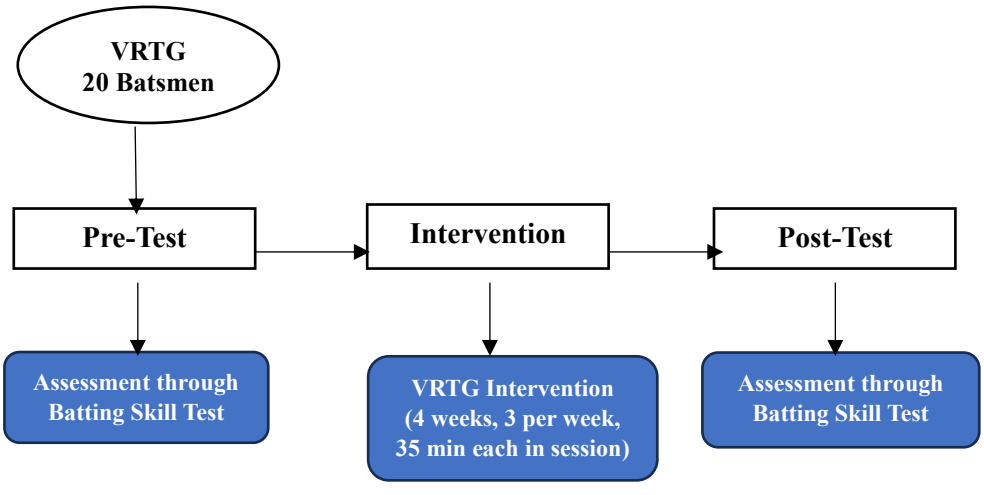

Figure 15 Research Design

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Before the training program with the Oculus Quest 2 Advance VR device, the virtual reality training group (VRTG) received an introductory tutorial on how to use the iB cricket competition software that runs the Oculus Quest 2 Advance VR device and how to play the games. The frequency of attendance was three times a week, while the session lasted 35 min. In particular, in every session, the participants were able to play the games that were based on training, Batsmen usually take 2 shots in 1st week (Off-Drive Shot and Cover-Drive Shot). In which the degree of difficulty is increased in every session. In the 2nd week, the player will again attempt two shots (Square Cut Shot and Late Cul Shot), and the degree of difficulty will increase in each session like in the 1st week. 3rd week player will attempt 3 shots (On Drive Shot, Flick Shot, and Slog Sweep). In which the degree of difficulty will increase in every session like the 1st week.

Statistical Analysis: The SPSS 22.0 (Statistical Package for the Social Sciences) for Windows was used to perform analyses of the study's data. A paired samples t-test was conducted to evaluate the differences in batting skill ability of the participants of the virtual reality training group (VRTG) between the pre-and Post-test. Significant differences between the means across time were tested at the 0.05 alpha level.

Result:

A paired-sample t-test was conducted to evaluate the effect of the Virtual reality training schedule (VRTS) on batsmen's batting skill ability. The results showed a significant increase in the score of the batsmen score improved after training (Mean=78.97, SD=6.036) compared to the batsmen score before training (Mean=77.40, SD= 5.994), $t(19) = 2.278$, $p<0.05$. The mean increase in the test score was 1.575 with a 95% confidence interval ranging from .127 to 3.02.

Paired sample t-test for BSA

	Mean	Std. Dev.	Mean	Std. Dev.	Std. Error Mean	95% Confidence Interval of the Difference Lower	Upper	t	df	Sig. (2-tailed)
Pre-test	77.40	5.994	1.575	3.091	.691	.12794	3.02206	2.278	19	.034
Post-test	78.97	6.036								

Table 3 Paired sample T-test to Assess the Batting Skill Ability of Batsmen

Discussion:

The purpose of this study was to design and validate the virtual reality training schedule and investigate the effect of the training schedule on the batting skills of the batsmen. one based on a fully immersive virtual reality training schedule for cricket batting environments design and validation and the other based on the practical implementation of a training schedule for enhancement of the batting skill of the right-handed cricket batsmen. Before the virtual reality intervention, batting skill ability was assessed and after one month of intervention (12 practice sessions) batting skill was measured. Batsmen in experimental groups (VRTG), after the intervention, increased significantly in batting skill ability that was relevant to Cricket.

Furthermore, the research noted that participants, even within the constraints of a limited observation period, demonstrated an enhanced ability to discern characteristic points of skill. Kun Zhao and Xueying Guo (2022) suggested the advantages of VR technology, are that athletes and coaches should get better training to improve their abilities. They exhibited a heightened capacity to extract more nuanced information regarding movement patterns and their consequential effects. Notably, participants refined their focus on key elements of skill execution, including foot movement, bat direction, and forearm turn. Simultaneously, there was an observable enhancement in their ability to concentrate on the outcome of the skill, delving into details such as the direction and depth of the ball's trajectory. Hawkar Oagaz (2021) explored the descriptive training system within VR was designed to provide real-time feedback on posture, technique, and ball returns. This suggests that the virtual reality intervention not only positively influenced overall batting skill but also contributed to a more nuanced and focused understanding of the intricacies of cricketing movements and their outcomes. Dhawan Aishwar and et.al. (2015) did a pilot experiment on batting skills conducted with a batter to investigate collision detection and whether the better was able to maintain a high level of task engagement throughout.

Future studies should explore further research on the larger sample size of subject professionals in different domains of the coaching sector to provide a more comprehensive evaluation. The primary objective of this research was twofold: first, to formulate and validate a virtual reality (VR) training regimen specifically tailored for cricket batting, with a focus on complete immersion in virtual environments; and second, to examine the impact of this training schedule on the batting proficiency of right-handed cricket batsmen. Preceding the introduction of the virtual reality intervention, an assessment of batting skill proficiency was conducted. Following a one-month intervention comprising 12 practice sessions, a post-intervention evaluation of batting skills was undertaken. Remarkably, both experimental groups, those subjected to the VR training regimen (VRTG), exhibited a significant improvement in their batting skill, demonstrating its relevance to the sport of cricket.

Conclusion:

Overall, this study has shown the steps taken in creating a Virtual Reality training schedule, and especially each step has been examined by experts in the field of Virtual Reality and cricket training. Face validity of the training schedule has also been done through these experts, so the involvement of experts ensures the accuracy, credibility, and relevance of the training schedule and the positive feedback received by the experts for the development of the schedule is suitable. The purpose of this virtual reality training schedule is designed and validated so that batsmen can use it without any hesitation to improve their batting skills. During this study, practical implementation of the training schedule was done on batsmen which yielded positive effective results. The VR training in cricket coaching has proven to be an effective strategy for engaging batsmen and enhancing their batting skill ability. This VR training schedule provides engaging and interactive training opportunities.

Acknowledgments: The authors would like to thank professional cricket Coaches and VR Training Experts for giving their valuable time and expertise for the accomplishment of this study.

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