

Empowering Young Athletes: Elevating Anti-Doping Education with Virtual Reality

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Abstract

INTRODUCTION: In recent times, doping's prevalence in sports has gained substantial recognition, sparking a concerted effort from researchers, policymakers, and sports bodies to underscore the critical role of impactful anti-doping education initiatives.

OBJECTIVES: An exhaustive examination of current literature underscores a critical requirement for advanced educational interventions that can effectively combat the multifaceted challenges presented by doping across the spectrum of competitive and recreational athletes.

METHODS: In response to this exigency, this paper introduces an innovative paradigm to redefine anti-doping education through the fusion of virtual reality (VR) technology. This proposed approach seeks to leverage VR's immersive potential, offering dynamic and interactive learning experiences that authentically mirror the complexities surrounding doping decisions.

RESULTS: The technical evaluation methodology for the VIRAL application was designed to provide a thorough assessment of its technical components and user experience. Overall the VR application scored 7,4 out of 10 regarding its technical aspects and characteristics.

CONCLUSION: By immersing athletes within lifelike scenarios, VR education aims to provide a nuanced understanding of the psychological and emotional facets associated with doping, all within a secure and controlled environment. However, while the potential of VR in anti-doping education is promising, it also necessitates addressing technical, ethical, and usability considerations, an aspect that this paper further explores.

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1. Introduction

Doping, the unauthorized utilization of substances or methods to enhance athletic performance, remains a widespread concern within the realm of sports, undermining equitable competition principles and posing risks to athletes' well-being and integrity. In response, various initiatives have been introduced to educate against doping behavior and encourage ethical sporting conduct [8]. However, despite these endeavors, doping's prevalence persists, suggesting the potential limitations of conventional educational methods.

Existing literature concerning anti-doping education underscores the crucial requirement for inventive strategies capable of deeply engaging athletes. While some educational interventions show promise, a knowledge gap remains concerning the most efficacious means to enhance athletes' comprehension of the repercussions of doping and the significance of adhering to clean sportsmanship.

This endeavour aims to tackle these issues by advocating a transformative shift in anti-doping education through the integration of virtual reality (VR). VR has emerged as a potent tool across various sectors, with its potential to generate immersive and interactive encounters making it an auspicious

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medium for educational contexts. By simulating real-life scenarios and affording users the ability to make decisions and witness outcomes within a secure setting, VR holds the potential for fostering more profound learning experiences compared to traditional methods.

The main objective of this research, building upon prior work [1], is to propose the creation of an advanced virtual reality application, meticulously tailored for both competitive and recreational athletes, to elevate the efficacy of anti-doping education. This initiative aims to inculcate a heightened comprehension of doping's perils and consequences while fostering a more robust commitment to equitable play and ethical competition. Throughout this paper, we will explore the rationale behind adopting VR technology for anti-doping education, delineating its potential advantages and addressing possible challenges. Additionally, we will delve into the envisioned design and development of the VR application, offering insights into the practical realization of this innovative educational approach.

2. Doping Use in Sports

Doping in sports refers to the use of prohibited substances or methods by athletes to enhance their performance, gaining an unfair advantage over competitors. These prohibited substances encompass a wide range, from anabolic steroids and hormones to stimulants, diuretics, and blood doping, all of which pose significant risks to the health of athletes and undermine the integrity of sporting competitions [2]. While the allure of achieving rapid success may tempt some athletes to turn to doping, the severe side effects associated with its use are a cause for grave concern [11]. Anabolic steroids, for instance, can lead to hormonal imbalances, resulting in increased aggression, mood swings, and potential long-term damage to vital organs [11]. Stimulants, on the other hand, can elevate heart rate and blood pressure, placing strain on the cardiovascular system and increasing the risk of heart-related problems [3]. The practice of blood doping, which involves transfusions or the use of erythropoietin (EPO) to boost red blood cell counts, heightens the risk of blood clots, strokes, and other circulatory complications [4]. Additionally, diuretics, often used to mask the presence of doping substances, can lead to dehydration, electrolyte imbalances, kidney problems, and muscle cramps [15]. Beyond these health-related risks, doping erodes the fundamental principles of fair play, integrity, and honesty that underpin sports [19]. Athletes who resort to doping gain an unfair advantage over their clean competitors, resulting in a distorted playing field that can disillusion athletes and spectators alike. This

multifaceted issue underscores the importance of rigorous anti-doping measures and education to preserve the sanctity of sports.

2.1. Determinants of doping

The psychological determinants of doping offer valuable insights into the intricate cognitive and emotional factors that shape an athlete's choice to engage in performance-enhancing practices. Doping decisions are multifaceted, influenced by a blend of personality traits, motivational forces, cognitive processes, and emotional dynamics. Notably, research has revealed that individuals who engage in doping exhibit distinct personality traits, such as higher levels of neuroticism, lower openness to experience, and decreased agreeableness, when compared to users of nutritional supplements and non-ergogenic substances [14].

Motivation plays a pivotal role in the realm of doping, with self-determined and autonomous motivation emerging as significant factors influencing an athlete's regulation of motivations regarding doping avoidance. The concept of need satisfaction is also crucial; it is inversely related to doping intentions, whereas need thwarting is positively associated with such intentions. A noteworthy finding is that athletes who have self-reported past doping use and possess mastery-avoidance goals are more inclined to consider doping in the future [14]. Interestingly, doping tends to be prevalent in leisure sports, where individuals seek rapid results, aim to push their limits, and desire faster recovery.

The decision to use doping is not made in isolation; it is influenced by a web of factors. Attitudes, social norms, and efficacy beliefs serve as mediators, influencing the impact of achievement goals on doping intentions. Additionally, situational temptation mediates the effects of achievement goals on intentions to use doping, while attitudes mediate the influence of sportpersonship [15].

Furthermore, anticipated regret from using PAEDs emerges as a robust predictor of doping intentions, interacting significantly with social norms, suggesting that the influence of anticipated regret on doping intentions is modulated by the prevailing social norms within an athlete's environment. This complex interplay of psychological determinants underscores the need for comprehensive anti-doping education and intervention programs that address the cognitive and emotional dimensions of this issue within the sporting community.

In summary, the decision to engage in doping is a complex process influenced by a multitude of psychological determinants, encompassing personality, motivation, cognitive factors, emotional states, ethical considerations, and environmental influences. Understanding these psychological facets is crucial for the development of effective anti-doping strategies and interventions in the realm of sports.

2.2. Anti-doping education: existing gaps and future trends

Doping in sports has spurred the development of various anti-doping interventions aimed at educating athletes and discouraging doping behaviors. Prominent among these initiatives are ATLAS and ATHENA, education-based programs known for their extensive use and proven short- and long-term benefits. [3] introduced a school-based intervention, expanding the array of anti-doping strategies. [17] designed an ethical decision-making intervention targeting athletes to limit doping use, emphasizing the role of moral reasoning in athletes' choices.

Several other noteworthy anti-doping interventions have also emerged, each offering distinct approaches to combat doping. CoachMADE, by [19], explores the coaches' influence in promoting ethical behavior among athletes. VIRTUE [11] addresses the psychological factors underlying doping intentions, emphasizing the importance of psychological well-being. The SafeYou [2] initiative extends anti-doping education into the fitness domain. The IPLAYCLEAN program [18] introduces the dynamics of team sports into the anti-doping discourse, highlighting collective responsibility in maintaining clean competition.

A recurring theme in these interventions is a dual focus on health implications and ethical values. They educate athletes about the health risks associated with doping and instill the importance of fair competition and ethical decision-making. By equipping athletes with knowledge and nurturing strong moral foundations, these interventions act as powerful deterrents against doping behaviors.

Despite the proliferation of anti-doping interventions, distinguishing between empirically validated and unverified approaches is crucial. Future interventions should draw from existing research insights to create tailored education programs addressing the complexities of doping behavior. Moreover, the effectiveness of anti-doping messages largely depends on their mode of delivery. Recognizing the potential of new technologies, interventions like virtual reality [4]; [27] present innovative avenues for instilling an anti-doping mentality and promoting clean sports ethics among young athletes. In this ever-evolving landscape, the pursuit of effective anti-doping interventions remains essential to

safeguard the integrity of sports and the well-being of athletes.

3. The Use of Virtual Reality for Educational Purposes

VR is an immersive technology that generates computer-generated simulated environments, allowing users to interact and experience a three-dimensional space with a profound sense of presence. Utilizing VR headsets, the technology tracks users' head movements and presents real-time visual and auditory stimuli, resulting in a highly engaging experience. While the concept of VR can be traced back to Ivan Sutherland's development of the first head-mounted display system in the 1960s, significant advancements in computer processing power, graphics rendering, and sensor technology during the last two decades have propelled VR technology, making it more accessible for various educational purposes. [24].

VR technologies offer several advantages in educational practices, which can be categorized into three key areas. Firstly, immersive learning experiences enable active participation in scenarios and simulations, enhancing engagement and memorability. Research consistently demonstrates that VR stimulates participants' curiosity and interest in the subject matter [6], allowing learners to interact with virtual objects, environments, and situations, leading to a deeper understanding of complex concepts and real-world applications. Secondly, VR-based learning has shown to improve retention and recall of information compared to traditional teaching methods. Immersive VR environments immerse learners, allowing them to freely move and interact within the simulated space, leading to better memory consolidation and recall of details from scenes and objects encountered [22]. Lastly, VR provides a safe learning environment, particularly relevant in fields like medicine, aviation, and sports, where simulations can train learners without risking real-world consequences for patients, equipment, or athletes. In anti-doping education, VR simulations enable athletes to explore the consequences of doping without compromising their health or sporting careers.

Despite the numerous advantages VR can offer in educational practices, it is essential to consider the potential risks and challenges when designing and implementing such tools. Technological limitations and accessibility issues pose challenges, as VR technology is continually evolving, and hardware costs, system compatibility, and technical glitches need to be addressed [16]. Moreover, prolonged exposure to VR environments can lead to simulator sickness in some users, with symptoms similar to motion sickness, such as nausea and dizziness [13]. While VR's immersive capacity is a significant advantage, it

may not always improve learning performance [22], necessitating careful design to minimize the risk of simulator sickness and ensure user comfort. Ethical considerations are crucial as well, with privacy, data security, and user consent paramount, particularly when handling sensitive or personal information in VR-based educational programs [26]. These challenges must be proactively addressed to create effective and ethical VR learning experiences.

3.1. Exposure Therapy and Simulations of Social Interactions

Exposure therapy, a well-established psychological intervention for treating anxiety disorders and phobias [9], aims to gradually expose individuals to feared situations in a controlled environment, allowing them to confront their fears and reduce anxiety over time. Virtual Reality has emerged as a groundbreaking tool for conducting exposure therapy, providing a highly immersive and realistic environment for individuals to face their fears [5], [23]. In the context of anti-doping education, VR can simulate scenarios where athletes may encounter temptations to use performance-enhancing substances or engage in doping practices, allowing them to experience the psychological and emotional challenges associated with doping decisions safely and under controlled conditions.

VR technology also serves as a powerful tool to simulate social interactions, enabling practice in communication skills, assertiveness, and ethical decision-making across various social scenarios. For instance, a study implemented a virtual reality application for role-plays in social skills training for schizophrenia [21]. Similarly, athletes can engage with virtual characters portraying coaches, teammates, or competitors and participate in realistic conversations regarding anti-doping attitudes and behaviours. VR's immersive nature and interactive features offer valuable opportunities for athletes to develop vital skills and insights, thereby enhancing anti-doping education and promoting ethical behaviour within the sporting community. One prominent advantage lies in its capacity to reproduce realistic scenarios, providing athletes with immersive experiences that mirror the pressures and temptations they might encounter in actual competitive environments [12]. By simulating these real-world situations, athletes gain a deeper and more nuanced understanding of the multifaceted process of ethical decision-making when confronted with doping temptations.

Furthermore, VR-based exposure therapy is highly amenable to individualization, tailoring educational interventions to meet the specific needs and fears of each athlete [20]. This approach facilitates personalized and gradual exposure to doping-related scenarios,

allowing athletes to progress at their own pace. Such customization empowers athletes, fostering a sense of empowerment and control over their learning process.

Importantly, the skills acquired through VR-based exposure therapy extend beyond the virtual realm, finding practical applicability in real-life competitive settings [1]. The transferability of these skills enhances the value of anti-doping education, equipping athletes to make informed and ethical decisions when facing doping-related challenges in their sporting careers. Moreover, VR offers a secure practice environment, allowing users to experiment with various responses to social pressures associated with different stimuli [21]. This safety net provides users with the confidence and assertiveness required to resist doping attempts effectively. Finally, VR's unique capacity to facilitate enhanced empathy and perspective-taking skills is noteworthy [25]. Through interactions with virtual characters in carefully designed social scenarios, athletes gain invaluable insights into the motivations and pressures experienced by others. This experience promotes a more profound understanding of the broader impact of doping on the sporting community.

In summation, VR technology's remarkable capacity to replicate realistic doping-related scenarios, provide tailored and transferable learning experiences, establish a secure space for practice, and amplify empathy and perspective-taking skills positions it as a potent and innovative tool for anti-doping education. By harnessing these attributes, VR empowers athletes not only with comprehensive knowledge but also with the ethical values necessary to adeptly navigate the multifaceted challenges posed by doping in the realm of sports. Through immersive exposure to authentic doping scenarios and social dynamics, this cutting-edge approach equips athletes with the vital skills and profound insights essential for making well-informed, principled decisions within the sporting domain. Moreover, the applicability of these acquired skills to real-world situations amplifies the impact of anti-doping education, fostering a pervasive culture of clean sportsmanship and ethical conduct throughout the sporting community.

4. VIRAL: A Virtual Reality Application about Learning Anti-Doping

VIRAL, short for Virtual Reality in Anti-doping Learning, represents an innovative approach to tackling the complex issue of doping in sports. By leveraging the immersive capabilities of VR technology, this application seeks to create realistic, interactive scenarios that athletes may encounter within the fitness and sports environment. These scenarios are carefully designed to

stimulate critical thinking, enhance emotional intelligence, and sharpen decision-making skills among its users, primarily athletes.

The primary aim of VIRAL is to equip athletes with a comprehensive set of skills and insights necessary to navigate the intricate web of doping-related challenges. It does so by providing a safe and controlled virtual space where users can immerse themselves in scenarios that mirror real-world situations. Within these scenarios, athletes are encouraged to engage in self-reflection, enabling them to better understand their emotions, motivations, and responses in doping-related contexts.

Resilience, a crucial trait for athletes facing pressures related to appearance and performance, is a core component of VIRAL's educational approach. Users are presented with challenges that test their emotional fortitude and the ability to resist external pressures to engage in doping practices. By doing so, VIRAL fosters a sense of empowerment and control over one's decision-making processes, essential for athletes striving to maintain ethical conduct in the face of temptations.

VIRAL's scenarios cover a wide range of critical topics. Athletes are exposed to situations where they must address performance plateaus, cope with the influence of peers and social media, critically evaluate the hype surrounding Performance Enhancement Drugs (PEDs), and reevaluate their exercise and sport-related goals. Each scenario is meticulously crafted to achieve specific educational outcomes, such as recognizing different forms of social pressure to use PEDs, debunking common myths about PEDs, and understanding the potential health risks associated with their usage.

Each of the scenarios of VIRAL aims to achieve different outcomes. Some example scenes can be seen in Figure 1 A & Figure 1 B. VIRAL attempts to assist athletes to manage emotions and thoughts about appearance and performance plateaus, to recognize different forms and sources of social pressure to use Performance Enhancement Drugs (PEDs), identifying, and debunking, myths about using them, being aware of the side effects and risks of PEDs use. Additionally, the application promotes the reconsideration of exercise/sport goals with a focus on the health-enhancing properties of exercise and sport. The four scenarios are as follows:

1. Overcoming plateau in appearance and/or athletic performance.
2. Coping with peer and social media pressure.
3. Dealing with the hype around Performance Enhancement Drugs.
4. Refocusing your Exercise Goals.

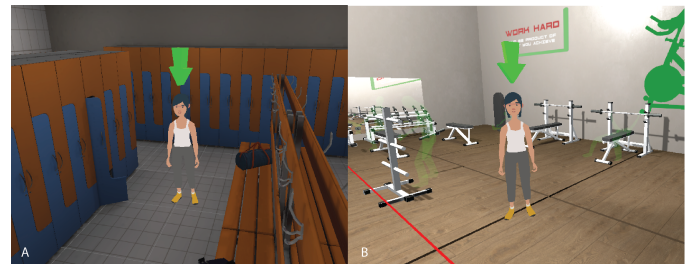


Figure 1. A. & B. are showcasing two out of four Scenarios in the VR application.

Ultimately, the VIRAL application represents a significant leap forward in anti-doping education. It empowers athletes not only with knowledge but also with the emotional intelligence and critical thinking skills necessary to make informed, ethical choices in the realm of sports. By creating a virtual space that mirrors reality and immersing users in scenarios that challenge their decision-making, VIRAL fosters a culture of clean sportsmanship and equips athletes to navigate the complex ethical landscape of competitive sports confidently.

4.1. Learning outcomes

VIRAL is designed to impart a comprehensive set of essential knowledge, skills, and insights to athletes, with a primary focus on addressing doping in sports and related challenges. Through immersive virtual reality scenarios, the application aims to empower users with the following learning outcomes:

Within the VIRAL application, users are exposed to scenarios mirroring real-life situations where athletes often encounter performance or appearance plateaus. These scenarios are thoughtfully designed to elicit emotional responses and thought patterns that are characteristic of such challenges, prompting users to engage in introspection and deeper self-understanding. Through this process, individuals develop heightened self-awareness, gaining insights into their emotional triggers and cognitive patterns, which is a fundamental step in nurturing emotional intelligence. Moreover, VIRAL equips users with practical coping strategies, empowering them to effectively manage the challenging thoughts and emotions associated with performance plateaus. These strategies extend beyond the virtual realm, offering users valuable tools for coping with life's various challenges. Furthermore, by navigating these scenarios and applying coping strategies, users gradually build resilience and mental strength, preparing them to face similar challenges in reality with poise and confidence. This holistic approach not only aids users in making ethical decisions concerning doping within the application but also enhances their emotional intelligence and mental fortitude for broader life situations.

Additionally, VIRAL users will be exposed to scenarios encompassing a spectrum of social pressures related to Performance Enhancement Drugs (PEDs), ranging from overt and direct offers to more insidious influences propagated through platforms like social media. This exposure serves as an educational tool, helping users recognize the multifaceted nature of these pressures. Through immersive experiences, users will develop a keen awareness of how various factors, including peer influence, societal trends, and media portrayals, can shape attitudes and behaviors related to doping. VIRAL goes beyond recognition by offering users a repertoire of strategies to effectively resist these pressures while maintaining ethical conduct and personal integrity. These strategies empower users to make informed and morally sound decisions, not only within the virtual scenarios but also in real-life situations where they may encounter similar temptations.

The VIRAL application places a significant emphasis on cultivating the mental strength required to resist the allure of PEDs when confronted with tempting situations. Through immersive scenarios and guided experiences, users will develop a robust inner resilience and the psychological tools necessary to firmly decline PEDs. This mental fortitude is not only crucial for individual athletes but also serves as a cornerstone for upholding the principles of clean sportsmanship and ethical behavior within the broader sporting community. By instilling in users the ability to confidently say "no" to PEDs, VIRAL contributes to fostering a culture of integrity and fairness, where athletes can compete on a level playing field based on their natural talents and hard work. This skill extends beyond the virtual realm, empowering users to make principled decisions in real-life sporting scenarios, thereby promoting the overall well-being of athletes and the ethical foundation of the sports they engage in.

VIRAL is designed to tackle the pervasive issue of online misinformation and hype associated with PEDs. In today's digital age, athletes are often bombarded with misleading claims and sensationalized information about such drugs, making it crucial to develop critical thinking skills to discern fact from fiction. Through immersive educational experiences, VIRAL will empower users to critically evaluate online content related to PEDs, teaching them to question the legitimacy of sources, scrutinize the evidence presented, and distinguish between scientifically sound information and unfounded claims. By honing these critical thinking abilities, users will be better equipped to make informed decisions regarding PEDs, safeguarding their health, integrity, and commitment to clean sportsmanship. This skill extends beyond the virtual realm, allowing users to navigate the complex landscape of online information effectively.

VIRAL recognizes the significance of encouraging athletes to reflect on their exercise and sports-related goals. In the competitive world of sports, there can often be an undue emphasis on external factors like appearance and performance metrics. Athletes may feel pressured to prioritize these aspects over their overall well-being and personal satisfaction. Through its immersive VR scenarios and educational content, VIRAL aims to instill a shift in perspective. It encourages athletes to broaden their focus, moving beyond superficial goals and embracing a holistic approach to their athletic pursuits. This shift involves considering the health-enhancing aspects of exercise and sports, emphasizing the physical and mental benefits that come with participation. By fostering a deeper understanding of the intrinsic rewards of sports and exercise, such as improved physical fitness, mental well-being, and personal satisfaction, VIRAL aims to promote a healthier and more balanced approach to athletic goals. This not only contributes to athletes' overall well-being but also aligns with the principles of clean sportsmanship and ethical behavior by reducing the allure of shortcuts like PEDs. Ultimately, VIRAL seeks to empower athletes to derive genuine fulfillment from their sporting endeavors while maintaining their commitment to ethical conduct in sports.

Additionally, VIRAL places a strong emphasis on highlighting the health-enhancing and fulfilling aspects of exercise and sports participation. Through its immersive VR scenarios and educational content, users will not only acquire knowledge about the potential risks and consequences of doping but also gain a deeper appreciation for the positive impact of physical activity on their overall well-being. VIRAL seeks to instill a profound understanding of how exercise contributes to physical fitness, mental well-being, and personal satisfaction. By promoting this holistic perspective, VIRAL aims to inspire athletes to derive genuine fulfillment from their participation in sports and exercise, reinforcing the idea that the true rewards of athletic endeavors extend far beyond external achievements. This perspective aligns with the principles of clean sportsmanship and ethical behavior, reinforcing the importance of maintaining one's health and well-being while pursuing athletic goals. Ultimately, VIRAL strives to empower athletes with the knowledge and mindset necessary to make informed and ethical choices in their sporting journey, prioritizing their long-term well-being and the integrity of the sporting community.

Furthermore, VIRAL is dedicated to promoting a more positive perspective on exercise and addressing common concerns related to body image and performance. Within the immersive VR environment, athletes will have the opportunity to explore and implement strategies aimed at cultivating a healthier and

more constructive mindset in their approach to fitness and sports. By engaging with VIRAL's scenarios and content, users can effectively address stress and anxiety associated with appearance and performance concerns. Through guided self-reflection and practical techniques, athletes will develop the mental tools needed to approach their physical pursuits with greater confidence, self-acceptance, and resilience. VIRAL's mission is to empower athletes not only with the knowledge to make ethical choices but also with the mental and emotional resilience to navigate the often-challenging landscape of competitive sports. In doing so, VIRAL aims to contribute to a sporting culture that prioritizes holistic well-being, fosters a positive relationship with exercise, and upholds the values of clean sportsmanship and ethical conduct.

4.2. Technical Specifications

Certainly, the development of the VIRAL VR application was anchored in the Unity platform [10], a comprehensive and widely adopted tool known for its ability to create dynamic real-time 3D experiences across a broad spectrum of platforms. This included augmented reality (AR), virtual reality, mobile devices, desktop computers, and web-based applications. Unity's versatility was instrumental in constructing a VR environment that could effectively simulate the complex social scenarios and decision-making processes related to doping in sports.

To enable the VR capabilities essential for VIRAL, Unity was augmented with various packages. Among them, the XR Toolkit played a central role. This toolkit provided the necessary features and functionalities for creating immersive virtual environments within the application, allowing users to seamlessly navigate and interact with the simulated scenarios. It ensured that the VR experience was not only immersive but also user-friendly and intuitive, making anti-doping education engaging and impactful.

VIRAL was purposefully designed to be compatible with the Oculus Rift 2 [7] headset, a leading VR hardware device, and its associated joysticks. This compatibility was critical in ensuring that users could fully immerse themselves in the anti-doping scenarios, utilizing the Oculus Rift 2's advanced tracking and input capabilities. By leveraging this technology, VIRAL aimed to deliver an authentic and responsive VR experience, thereby enhancing the effectiveness of its educational objectives.

In terms of visual design, VIRAL adopted a strategic approach by opting for low-poly avatars to represent virtual trainers and gym buddies within the application. This decision was driven by a desire to address the uncanny valley effect, a phenomenon where human-like characters that fall short of being convincingly

realistic can evoke discomfort or unease in users. By choosing low-poly avatars, VIRAL struck a balance between visual simplicity and user comfort. This design choice was pivotal in creating an environment where users could interact with virtual characters in a more relaxed and relatable manner, fostering a conducive atmosphere for effective anti-doping education.

Architecture and Design. The foundation of the VIRAL application rests upon the Unity game engine, a robust and versatile platform renowned for its exceptional rendering capabilities and comprehensive support for VR technology. This choice of engine was instrumental in creating a VR experience that seamlessly blended realism with interactivity, enhancing the overall educational impact. Unity's ability to handle complex 3D environments and its robust support for VR made it the ideal choice for constructing VIRAL.

The architectural structure of VIRAL is rooted in a modular design philosophy. This design approach allows for the effortless expansion and integration of new scenarios, features, or content into the application. The modularity of VIRAL not only streamlines the development process but also ensures the flexibility needed to adapt the application to evolving educational requirements and emerging trends in anti-doping education. This adaptability is essential in keeping VIRAL up-to-date and relevant in the ever-evolving landscape of sports and doping prevention.

Interaction mechanics within VIRAL, such as user input and avatar behaviors, are implemented using Unity's scripting capabilities. This scripting framework provides the necessary tools to create dynamic and responsive interactions within the VR environment. It enables users to engage with the virtual scenarios, make decisions, and witness the consequences of their choices in a realistic and immersive manner. Unity's scripting capabilities are leveraged to deliver an educational experience that not only informs but actively involves users in the learning process, enhancing retention and understanding of the anti-doping content.

User Experience. The VIRAL application offers users an immersive and captivating experience within its virtual reality environment. This immersive quality is a fundamental aspect of VIRAL's design, as it enables users to actively engage with a diverse range of social scenarios. These scenarios are crafted to replicate real-world situations that athletes might encounter, providing a true-to-life platform for learning about doping-related challenges. To further enrich the authenticity of these social interactions, VIRAL incorporates avatars that are meticulously designed to be both realistic and emotionally expressive. The use of avatars adds depth and believability to the interactions within the VR environment, making it easier for users to connect with the scenarios and characters they

encounter. This emotional expressiveness of avatars enhances the overall authenticity and impact of the educational experience, allowing users to better relate to and empathize with the situations presented.

The user interface (UI) within VIRAL is carefully crafted to be intuitive and unobtrusive. This design ensures that users can seamlessly navigate through the various scenarios and access the information they need without any hindrance. The intuitive UI promotes a smooth and user-friendly experience, minimizing any potential barriers that might impede the learning process. By prioritizing ease of use and accessibility, VIRAL maximizes the educational benefits of its VR environment, making it a highly effective tool for anti-doping education.



Figure 2. The application's Main Menu.

Performance. VIRAL places a strong emphasis on delivering a seamless and comfortable virtual reality experience for its users. To achieve this, the application utilizes a range of optimization techniques tailored to the unique demands of VR environments. One key optimization technique employed is occlusion culling. This technique selectively renders only the objects and elements that are within the user's field of view, effectively "hiding" objects that are obstructed from sight. By doing so, VIRAL conserves computational resources, allowing for more efficient rendering and smoother performance. This not only enhances the overall VR experience but also contributes to reducing the risk of motion sickness, a common concern in VR.

Furthermore, VIRAL employs a level-of-detail management system. This system dynamically adjusts the level of detail for objects and elements in the VR environment based on their proximity to the user. Objects that are farther away from the user are rendered with lower detail, reducing the computational load. As users approach these objects, their level of detail is gradually increased to maintain visual quality and immersion. This dynamic LOD management ensures

that VIRAL maintains high frame rates, contributing to a comfortable and nausea-free experience for users. By implementing these optimization techniques, VIRAL prioritizes user comfort and immersion, making it an effective and enjoyable tool for anti-doping education in the VR space.

Technical Compatibility. VIRAL is designed with a strong emphasis on cross-platform compatibility, ensuring accessibility for a wide range of users across various major VR platforms. The application is optimized to function seamlessly on popular VR systems, including Oculus Rift, HTC Vive, and Windows Mixed Reality. One of the primary advantages of this cross-platform approach is the broad reach it offers, allowing users with different VR hardware to access and benefit from VIRAL's educational experiences. By targeting multiple VR platforms, the application caters to the diverse preferences and setups of its user base. Furthermore, VIRAL prioritizes compatibility with Windows-based systems, which are commonly used for VR experiences. By adhering to the requirements of most VR-capable computers, the application ensures that a substantial portion of users can run it effectively without the need for extensive hardware upgrades or adjustments. Overall, VIRAL's commitment to cross-platform compatibility enhances its accessibility and usability, making it a valuable tool for anti-doping education across a wide spectrum of VR users and setups.

Data Security and Privacy. VIRAL prioritizes data security and user privacy by safeguarding all user data, encompassing interactions and progress, securely within the application, preventing external sharing. Additionally, for data collected in research contexts, VIRAL meticulously adheres to the rigorous data protection guidelines mandated by the European project. This unwavering commitment to user data confidentiality and privacy fosters a secure environment for research purposes while respecting individuals' rights and privacy. VIRAL's dedication to data security ensures that user information is treated with the highest ethical standards, aligning with its anti-doping education mission.

Localization – Multilingual Support. When all scenarios were completed in English and integrated into the game, the scripts were sent to all partners, in order to be translated into Greek, Romanian, German, Danish, and English. For the translations, Unity provides a localization feature, which exports all dialogues and user interface elements in a comma-separated file (.csv) for each scenario. These files were sent to the partners in order to be translated. Also, for elements like buttons that were custom-made, these necessary translations were in separate files. The .csv files were merged into one for each scenario and then imported to Unity.

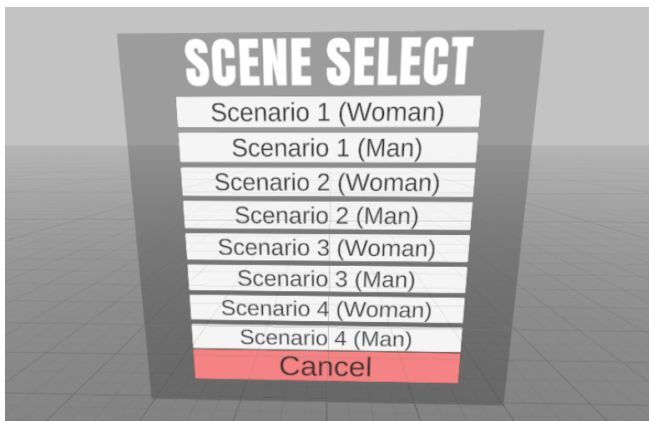


Figure 3. In our attempt of inclusion regarding not only ethnicity but genders as well, we designed all the scenarios in both male and female versions, for the user but also for the person they are interacting with.

5. Evaluation

VIRAL represents advanced software developed through the utilization of the Unity game engine. Its primary objective is to simulate social scenarios with the intent of enhancing social skills development. The purpose of this technical evaluation is to comprehensively assess essential technical components of the VIRAL application, encompassing its design, user interface, performance characteristics, and compatibility considerations. The technical evaluation for the VIRAL application is designed to comprehensively assess the technical facets, features, and functionalities inherent to the application that collectively contribute to its efficacy, safety, user-friendliness, and overall quality. This evaluative process assumes significance as it ensures that the VR application is meticulously designed to achieve therapeutic objectives while delivering a comfortable and immersive user experience.

5.1. Methodology

The technical evaluation methodology for the VIRAL application was designed to provide a thorough assessment of its technical components and user experience. This evaluation involved a group of 10 participants with varying levels of familiarity with virtual reality technology. These participants engaged with different aspects of the application, including menus, scenarios, settings, avatars, and objects, to evaluate the user interface's intuitiveness and interaction design. To gauge the application's realism, participants interacted with the virtual scenarios created within VIRAL, and post-interaction interviews and surveys were used to gather insights on elements

like textures, lighting, spatial accuracy, and the effectiveness of environmental cues.

Furthermore, the diversity and customization potential of the scenario design were examined through participant engagement with various scenarios, and feedback was analyzed to assess the range of scenarios available and the extent of customization options offered. Additionally, participant interaction with avatars and objects within the virtual environment provided valuable insights into the realism of behaviors, including body language, facial expressions, and the authenticity of movements.

The evaluation process also considered the comfort of motion-based interactions and camera movements, with participants providing feedback on their experiences. To ensure a smooth user experience, the performance of VIRAL was monitored, focusing on consistent frame rates during participant interactions. Lastly, the ease of the installation process was assessed by examining documentation and participants' responses to a post-installation survey, offering insights into the user-friendliness of the setup procedure.

In summary, this comprehensive evaluation methodology incorporated participant engagement, data collection following interaction sessions, and observational analysis. It aimed to provide a holistic evaluation of VIRAL's technical components and the overall user experience, encompassing its diverse functionalities and features.

6. Results

Overall the project scored 7,4 out of ten regarding its technical aspects and characteristics. A more detailed analysis of the results can be seen in Figure 4.

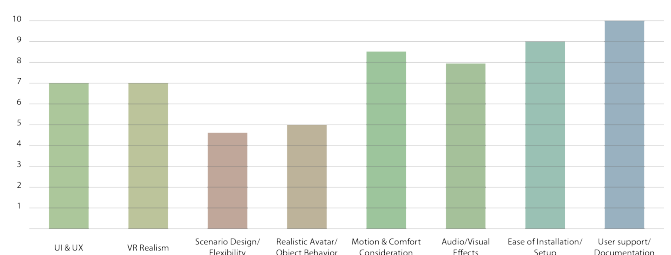


Figure 4. The results from the Technical evaluation of the VIRAL project.

Regarding user interface and interaction, the VIRAL application demonstrates a commendable level of sophistication and user-friendliness within its VR environment, garnering a noteworthy rating of 8 out of 10. This high score attests to the application's success in providing participants with an intuitive and accessible interface, which significantly streamlines navigation and interaction processes. Furthermore, the careful design of interaction methods is evident, encompassing

various modalities such as controllers, and gestures. These design choices aim to cater to a broad spectrum of users, irrespective of their prior experience with VR, thus contributing to an overall rating of 6 out of 10.

The VIRAL application showcases a commendable level of fidelity, earning a rating of 7 out of 10 in terms of virtual environment realism. This rating is reflective of the meticulous attention to detail in creating a well-curated virtual environments. Notably, VIRAL excels in areas such as textures, lighting, and spatial accuracy, collectively contributing to an immersive and authentic user experience. Furthermore, the application adeptly integrates environmental cues, mirroring real-world scenarios commonly encountered in gym floors and similar spaces. These cues are faithfully represented, effectively contributing to the creation of a convincing social context within the virtual environment. Such a focus on realism aligns with the best practices in VR application development, enhancing the application's overall efficacy in providing users with an engaging and authentic learning experience.

In assessing the scenario design and flexibility within the VIRAL application, it is evident that there are both strengths and areas for improvement. The application offers a moderate level of diversity concerning the scenarios it presents, scoring 5 out of 10. These scenarios are thoughtfully designed to be relevant to anti-doping research, addressing a spectrum of social encounters and challenges that young athletes may encounter. However, there exists room for expansion in this regard, with potential for enhancing the diversity of scenarios further to provide a more comprehensive learning experience. One notable feature is the application's inability to facilitate customization of scenarios, earning a rating of 4 out of 10. This customization functionality should enhance the adaptability of the application, allowing researchers to tailor scenarios to meet individual user needs.

The evaluation of realistic avatar and object behavior within the VIRAL application reveals several noteworthy aspects. Avatars and objects deployed in VIRAL demonstrate behaviors that align with real-world interactions with a score of 5 out of 10 in this assessment. They respond authentically to users' actions, contributing to a sense of immersion and engagement within the virtual environment. Furthermore, the application places significant emphasis on the faithful representation of body language, facial expressions, and avatar movements, ensuring that these aspects closely mirror genuine social interactions, also receiving a rating of 5 out of 10.

In regards to motion and comfort considerations within the VIRAL application underscores its commitment to providing a comfortable and immersive user experience. The application achieves consistently high

frame rates, earning a score of 8 out of 10 in this assessment. This frame rate optimization effectively prevents motion sickness, a common concern in virtual reality experiences, ensuring that participants can engage in VR sessions comfortably and without discomfort. Moreover, VIRAL's meticulous design of motion-based interactions and camera movements is highly effective in minimizing discomfort and potential adverse effects during VR sessions, receiving an impressive rating of 9 out of 10. This approach prioritizes user well-being and contributes to a seamless and enjoyable interaction with the application. Overall, the motion and comfort considerations within VIRAL significantly enhance the quality of the virtual learning environment, promoting a positive and user-friendly experience for all participants.

As of audio and visual effects within the VIRAL application, it is evident that the design prioritizes creating a captivating and authentic virtual experience. VIRAL excels in this aspect, earning a rating of 8 out of 10. The application provides users with high-quality audio cues that enhance the overall immersion, contributing to a heightened sense of realism and engagement. This careful attention to audio, coupled with visually immersive effects, collectively enriches the user experience. As a result, participants can effectively engage with the application's content, making the learning process more engaging and memorable. This dedication to audio and visual quality underscores VIRAL's commitment to delivering a top-tier educational tool within the realm of anti-doping education, further enhancing its effectiveness as a medium for fostering ethical decision-making among athletes.

Furthermore, we accessed the ease of installation and setup for the VR application, which revealed a highly user-friendly experience, earning a rating of 9 out of 10. Users have reported that the installation process is straightforward and uncomplicated, facilitated by clear and accessible instructions. One of the notable strengths of VIRAL is its inclusivity, as it caters to individuals with varying levels of technical expertise. This user-centric approach ensures that a wide range of users, including those who may not be particularly tech-savvy, can easily navigate the installation and setup procedures.

Finally, the evaluation of user support and documentation for the VIRAL indicates an exemplary performance, earning a perfect rating of 10 out of 10. VIRAL goes above and beyond in providing robust user support resources to assist users in effectively utilizing the application. These resources are designed to empower users with the knowledge and skills needed to navigate VIRAL seamlessly, ensuring that they can make the most of its educational features. By offering such comprehensive user support, VIRAL not only enhances

the user experience but also reinforces its commitment to delivering high-quality anti-doping education.

7. Discussion

In conclusion, a comprehensive understanding of doping's history, risks, and protective factors is vital to combat this issue effectively. By implementing robust anti-doping education, creating a supportive athlete environment, and enforcing stringent testing and sanctions, the sports community can uphold fair play principles and prioritize athlete well-being. Integrating VR technology into anti-doping education shows great promise in delivering transformative learning experiences. Addressing potential risks and challenges through careful design, ethical considerations, and continuous improvement will enhance the effectiveness of VR-based educational initiatives. Leveraging VR benefits, the sports community can revolutionize anti-doping education, instilling knowledge and ethical values that foster a culture of clean sport and fair competition. Evaluating the VR application's impact on athletes' decision-making, behaviour, and attitudes towards doping is a crucial future step. Thorough assessments and user feedback will enable researchers to continually refine and enhance the VR application, solidifying its role in the fight against doping in sports.

7.1. Customization and Personalization

The application possesses the capacity to offer tailored experiences congruent with the specific requirements of individual users. It demonstrates adaptability in accommodating various demographic factors, including sex, race, language, and hearing impairment. This customization capability underscores the application's commitment to providing inclusive and personalized experiences to a diverse user base.

7.2. On the Technical Evaluation

The technical evaluation of the VIRAL application employs a meticulous and comprehensive approach, systematically scrutinizing its core components. Firstly, the user interface is thoughtfully designed to ensure effortless navigation and interaction, catering to users with diverse levels of familiarity with VR technology. This inclusive design facilitates a smooth and user-friendly experience, with an average score of 7/10. Adding to its user-friendliness, VIRAL's installation process is straightforward and welcoming, making it accessible to users with varying technical backgrounds. Additionally, the comprehensive user support resources enhance the overall experience, ensuring that users can readily access assistance when needed.

VIRAL's virtual environments are remarkable for their high level of detail, emulating real-world

scenarios, while avoiding the Uncanny Valley effect. This attention to detail significantly bolsters the immersive quality of the social context within the application. Users are presented with environments that imitate real life, without mirroring it, enhancing the authenticity of the learning experience.

A standout feature of VIRAL is its scenario design, which is both diverse and adaptable. This versatility accommodates a wide spectrum of anti-doping research scenarios and allows for customization to meet individual user preferences. It ensures that researchers can effectively tailor their experiments to their specific needs.

Moreover, the realism exhibited by the avatars and objects within VIRAL is striking. They convincingly mimic real-world interactions, creating an authentic and engaging environment for users.

In terms of user comfort, VIRAL excels in maintaining smooth experiences by ensuring high frame rates, thereby preventing motion sickness. This consideration is particularly crucial in VR applications, where user comfort can significantly impact the effectiveness of the experience.

VIRAL doesn't stop at visual quality; it also delivers on the audio and visual effects front, elevating engagement levels in social scenarios. This immersive sensory experience contributes to a more profound and memorable learning journey.

VIRAL's compatibility with a wide range of VR hardware devices and platforms ensures accessibility for researchers, promoting collaborative and interdisciplinary anti-doping education and research.

In summary, VIRAL stands out with its robust technical attributes, spanning across the user interface, realism, customization, and user support. These attributes collectively position it as a valuable and effective tool for immersive and impactful anti-doping education and research.

7.3. On the Ethical side of designing VR Applications

In recent years, the rapid advancement of Virtual Reality technology has ushered in a new era of immersive experiences, transforming how we interact with digital environments. This transformative potential extends to various domains, including education, entertainment, healthcare, and beyond. Yet, as VR continues to evolve, so too do the ethical considerations surrounding its use. Among these, the principles of data security and privacy have emerged as paramount concerns, particularly in the context of designing VR applications. As the boundaries between the virtual and physical worlds blur, the ethical responsibility to protect users' personal information, ensure informed consent, and establish robust security measures becomes increasingly pronounced. In this discussion, we delve into

the ethical dimensions of data security and privacy in VR application design, examining the principles that underpin responsible development and deployment of these immersive technologies.

Data Security and Privacy. VIRAL ensures user privacy by not tracking, storing, or monitoring user data. This commitment creates a secure environment for research and education, aligning with data protection standards and respecting user privacy.

8. Conclusions

In conclusion, understanding the history, risks, and protective factors surrounding doping is essential in developing effective strategies to combat this issue. By implementing comprehensive anti-doping education, fostering a supportive environment for athletes, and enforcing stringent testing and sanctions, the sports community can uphold the principles of fair play and safeguard the well-being of athletes in pursuit of their sporting aspirations. Looking ahead, the integration of VR technology into anti-doping education holds immense promise for delivering impactful and transformative learning experiences. While there are potential risks and challenges associated with VR, addressing them through careful design, ethical considerations, and ongoing improvement will contribute to the effectiveness and success of VR-based educational initiatives. By leveraging the benefits of VR, the sports community can revolutionize anti-doping education and empower athletes with knowledge and ethical values that foster a culture of clean sport and fair competition. As a future step, evaluating the VR application's effectiveness in anti-doping education will be crucial to ensure its positive impact on athletes' decision-making, behaviour, and attitudes towards doping. By conducting thorough assessments and gathering feedback from users, researchers can continually refine and enhance the VR application, making it an increasingly valuable tool in the fight against doping in sports.

8.1. Future work

In future work, we envision conducting comprehensive user testing to further enhance the effectiveness and user experience of the VIRAL application. This user testing will involve a larger and more diverse participant pool, allowing us to gather valuable feedback and insights from athletes with varying backgrounds and levels of familiarity with anti-doping concepts and VR technology. By closely analyzing user interactions, preferences, and learning outcomes, we aim to fine-tune the application's scenarios, user interface, and interaction methods to better cater to the specific needs and expectations of our target audience, ensuring a more immersive and

embodied experience. Additionally, we will explore the integration of advanced elements to create more dynamic and personalized scenarios, providing users with an even more immersive and tailored learning experience. Through ongoing user testing and iterative development, we seek to continually improve and optimize the VIRAL application, ultimately advancing the field of anti-doping education and contributing to the promotion of clean sports ethics among athletes and the sporting community.

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