VIRTUAL REALITY IN SNOWBOARDING EDU-EXPERIENCE FOR BEGINNERS

By
Miss Siqi ZHANG

A Thesis Submitted in Partial Fulfillment of the Requirements
for Doctor of Philosophy Design
Silpakorn University
Academic Year 2024

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MissSiqi ZHANG

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Title	Virtual Reality in Snowboarding Edu-experience for Beginners
By	Miss Siqi ZHANG
Field of Study	Design
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As snowboarding becomes increasingly popular worldwide, it has drawn more people to this thrilling and fashionable winter extreme sport. However, those who wish to experience snowboarding must bear the high learning costs, including economic costs, time investment, and learning pressure. This study aimed to create an educational experience in a virtual reality (VR) world tailored for snowboarding beginners to help reduce learning costs.

The research objectives included investigating the educational experience needs of snowboarding beginners, analyzing the feasibility of applying VR technology to their educational experiences, and designing and developing a VR educational experience to test its feasibility.

This study employed a mixed-methods approach, adhering to user-centered design principles based on the ADDIE Model. It incorporated Constructivist Learning Theory, Scenario Design Theory, and gamification concepts. This study conducted a literature review and field investigations at five selected ski resorts, collected 429 valid questionnaires, and interviewed several relevant experts. The research team then proceeded with the design and development. After an expert evaluation of the prototype, further improvements were made based on the feedback. Finally, 15 volunteers participated in testing, with assessments conducted by three professional snowboarding instructors, evaluating both the volunteers' performance and the prototype.

The results were derived from user experience feedback, behavioral observations, user performance, and professional instructors' evaluations of both the user performance and the prototype. All evaluations indicated positive outcomes, demonstrating the effectiveness of the prototype.

The findings indicate that VR art has significant potential for improving the educational experiences of snowboarding beginners. It can effectively reduce learning costs, help beginners quickly transition to real-world snowboarding skills, and promote the inheritance and development of the winter sports culture.

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Siqi ZHANG

TABLE OF CONTENTS

Page

LIST OF TABLES

Page

LIST OF FIGURES

Page

CHAPTER 1

BACKGROUND OF THE STUDY

1.1 BACKGROUND AND SIGNIFICANCE OF THE PROBLEM

Since the 1960s, snowboarding has gradually gained popularity worldwide (Thorpe, 2012). In recent years, the sport’s visibility has significantly increased due to the grand events of the Winter Olympics and extensive social media promotion, attracting many beginners and enthusiasts (Barjolin-Smith, 2023). However, with the growing number of participants in snowboarding, numerous issues have emerged. As inexperienced snowboarding beginners aspire to liberate their minds and bodies by swiftly gliding over the snow, they face many challenges.

Although snowboarding blends fashion and excitement, it remains a challenging sport as a winter extreme activity (Wheaton, 2004). According to data analysis, more than half of the first-time participants in China abandoned the sport after their initial attempt (Bin Wu, 2018). The reasons for this phenomenon are multifaceted. Individuals must invest time in learning and training and face substantial financial costs. For example, one must travel to snowy regions or countries to experience essential snow sports. However, many first-time participants come from areas needing more geographical conditions to conduct such activities, forcing them to bear travel and accommodation expenses. Investors have constructed artificial indoor snow slopes in various countries and regions without natural conditions. Due to high construction costs, these facilities also incur high usage fees. Due to high construction costs, these facilities also incur high usage fees.

Moreover, snowboarding beginners seeking a better experience typically need to hire instructors to assist them in learning and training, which incurs additional time and financial costs (Reichenfeld & Bruechert, 1995). However, data show that the number of inexperienced snowboarding beginners is increasing, yet the number of instructors still needs to match this increase (Institute, 2022). Thus, even those who can afford instructor fees often need help in finding suitable instructors on available dates.

In addition to the costs of time and money, beginners frequently face psychological pressure (fear of injury), physical strain (snowboarding is physically demanding, and individuals pay hourly usage fees for facilities, instructor fees, and potential equipment rental fees, forcing them to endure physical exertion to maximize their investment), and learning and social pressures (Althen, 2015). These issues present significant challenges.

With technological advancements, education, training, and sports experiences have made great strides in various fields (Qi, Sajadi, Baghaei, Rezaei, & Li, 2024). As an interactive medium, certain technologies provide learners with unique learning experiences. Particularly in sports education, modern methods can potentially enhance traditional teaching methods (Bronikowski, 2011). Their control over time and the environment can help students focus on skill practice, improve learning outcomes and motivation, and reduce learning pressure. By integrating these technologies into the snowboarding educational experience, we can provide beginners with a safe and controlled environment to learn and practice snowboarding techniques, thereby significantly reducing their learning costs, as they no longer need to worry about injuries due to a lack of skills.

These technologies can simulate natural snowboarding environments and offer rich sensory experiences through visual and auditory feedback, allowing beginners to experience as close to reality as possible without leaving home. These technologies can also address the shortage of instructors; by recording tutorials or creating interactive teaching programs, beginners can receive snowboarding training in a technological environment, alleviating the burden of instructors (Craig, 2013a). Moreover, these technologies can effectively encourage beginners to participate and persist in snowboarding training. Combining snowboarding training with experience makes the learning experience more enjoyable, thus stimulating learners' interests and motivation.

In summary, many individuals show a strong interest in snowboarding, but as beginners, they are often discouraged by the high costs associated with learning the sport. Given limited resources, it is crucial to make the most of the existing resources to reduce these learning costs as much as possible. By optimizing and efficiently using available technologies and resources, it is possible to improve learning outcomes, alleviate learning pressure, and enhance sports participation. This approach not only addresses the challenges faced by snowboarding beginners but also contributes to the sustainable development of the sport.

1.2 RESEARCH HYPOTHESIS

1.2.1 Snowboarding beginners require flexible learning times and locations, cost-effective learning solutions, and beginner-friendly environments during their learning process.

1.2.2 Using VR to teach can significantly enhance snowboarding beginners' motivation and engagement.

1.2.3 VR instructional can content to meet the educational needs of snowboard beginners and enhance their overall edu-experience.

1.3 RESEARCH OBJECTIVES

1.3.1 To research the edu-experience needs to snowboard beginners.

1.3.2 To explore the potential of using VR to enhance the snowboarding edu-experience of snowboarding beginners.

1.3.3 Design, develop, and evaluate VR for snowboarding beginners for their edu-experience.

1.4 THE IMPORTANCE OF THE RESEARCH

1.4.1 ADVANCING INNOVATION IN SNOWBOARDING EDUCATION

First, by studying the educational needs of snowboarding beginners, this research provided a deeper and more precise understanding of snowboarding education, thereby providing theoretical support for developing more effective educational strategies. Second, the research explored the application of VR in snowboarding education, which may have led to new trends in snowboarding education and promoted its innovation and development.

1.4.2 PROMOTING THE PRACTICAL VIRTUAL REALITY APPLICATION

VR is an emerging technology and art form; however, its practical application still needs to be improved. This research explores the application of virtual reality in snowboarding education, which can provide a new field of application for VR and offer examples and insights for its application in other educational fields.

1.4.3 ENHANCING THE LEARNING EXPERIENCE OF SNOWBOARDING BEGINNERS

By using VR as a tool for snowboarding instruction, this study can significantly enhance the learning experience of snowboarding beginners, thereby attracting more people to participate in the sport and promoting the popularization and development of snowboarding.

1.4.4 CONTRIBUTION TO THE INHERITANCE AND DEVELOPMENT OF WINTER SPORTS CULTURE

Snowboarding, as an essential winter sport, has significant implications for the heritage and growth of the winter sports culture. This study should improve the learning experience of beginners. It may help more people engage in and participate in snowboarding, thereby contributing to the inheritance and advancement of the winter sports culture.

1.5 EXPECTED BENEFITS

1.5.1 CONTRIBUTION TO LEARNERS

The researchers expect that this research will offer a novel and innovative approach to enhance the learning experience of snowboarding beginners, helping them better master their snowboarding skills, reduce learning pressure, improve learning efficiency, and increase their passion for and involvement in snowboarding.

1.5.2 CONTRIBUTION TO EDUCATORS AND RESEARCHERS

The findings of this study will provide a new teaching tool and method for educators and researchers, enabling them to teach snowboarding skills more effectively and improving the quality of instruction. Simultaneously, this study will promote further applications and research into VR technology in the educational field.

1.5.3 CONTRIBUTION TO TECHNOLOGY AND INDUSTRY

This study will showcase the potential application of VR in physical education, paving the way for the development of VR technology and related industries, thereby promoting the advancement of these technologies and industries.

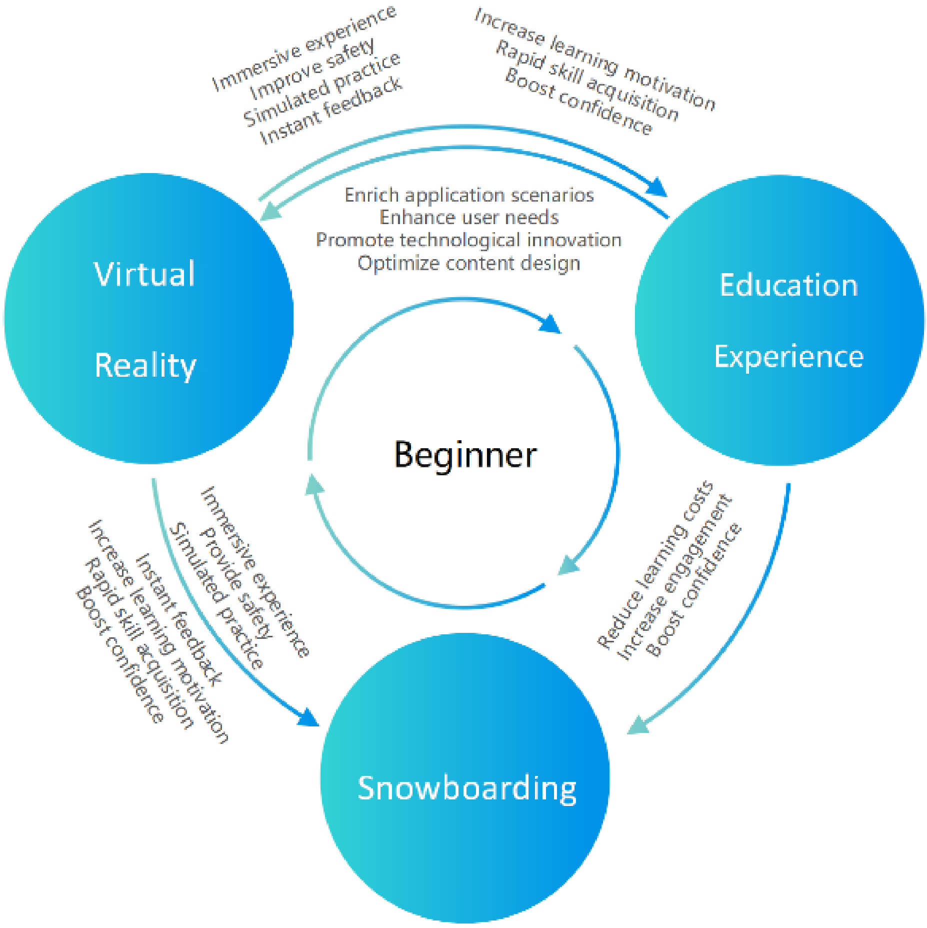
1.5.4 CONTRIBUTION TO SOCIETY

By enhancing the effectiveness and experience of snowboarding instruction, this study will encourage more people to participate in snowboarding, thereby promoting the popularity and development of snowboarding. The resulting promotion of the societal sports culture will have a positive impact.

1.6 CONCEPTUAL FRAMEWORK

Figure 1

The Conceptual Framework



Source: Designed by the author

In this study, the three core concepts of snowboarding, VR, and educational experience were combined to form an innovative educational model to reduce beginner learning costs and enhance learning outcomes and user experiences (Figure 1). Snowboarding is a challenging winter sport that requires beginners to master balance, coordination, and technical control. However, traditional learning methods often require more immersion and instant feedback, which causes beginners to encounter difficulties and frustrations during the learning process. VR technology creates an immersive virtual environment, providing highly interactive and realistic simulated experiences that allow beginners to practice safely and reduce injury risks. Through VR, students can engage in simulated practice under various conditions and receive immediate feedback and guidance, thereby accelerating skill acquisition. Educational experience enriches application scenarios and interactive design, enhances learning motivation and engagement, and boosts beginners' confidence. Overall, this educational model, which combines snowboarding, VR, and educational experiences, improves learning efficiency and effectiveness and provides beginners with a safe, supportive, and enjoyable learning pathway.

1.7 SCOPE OF STUDY

1.7.1 SUBJECT SCOPE

This study focused on snowboarding beginners. This research focused on the educational experiences of beginners and learning outcomes in the VR snowboarding world.

1.7.2 CONTENT SCOPE

The content scope includes analyzing the educational needs of snowboarding beginners, designing and developing a virtual reality snowboarding world, implementing VR-based teaching methods, and evaluating their impact on snowboarding skill proficiency, learning motivation, and user experience satisfaction. The study also used the SAMR Model to assess educational outcomes and the Kirkpatrick Model to evaluate user experience.

1.7.3 DESIGN SCOPE

The research design is based on the ADDIE Model and comprises five phases: analysis, Design, Development, Implementation, and Evaluation. The design process integrates Constructivist Learning Theory, Scenario Design Theory, and gamification concepts to create an immersive and interactive VR snowboarding educational experience.

1.7.4 GEOGRAPHICAL SCOPE

The geographical scope of this study is limited to the participants' locations, including the researchers' educational institutions and nearby snowboarding clubs. Because teaching uses VR technology, the study is not strictly bound by geographical location and can be conducted anywhere with VR devices.

1.7.5 METHODOLOGICAL SCOPE

The methodological scope includes both quantitative and qualitative methods. Quantitative methods involve using questionnaires and experimental tests to evaluate learning outcomes and user experiences. Qualitative methods include in-depth interviews and field observations to gather user feedback. Data analysis uses descriptive statistical analysis to test the research hypotheses and assess the effectiveness of the VR-based teaching method.

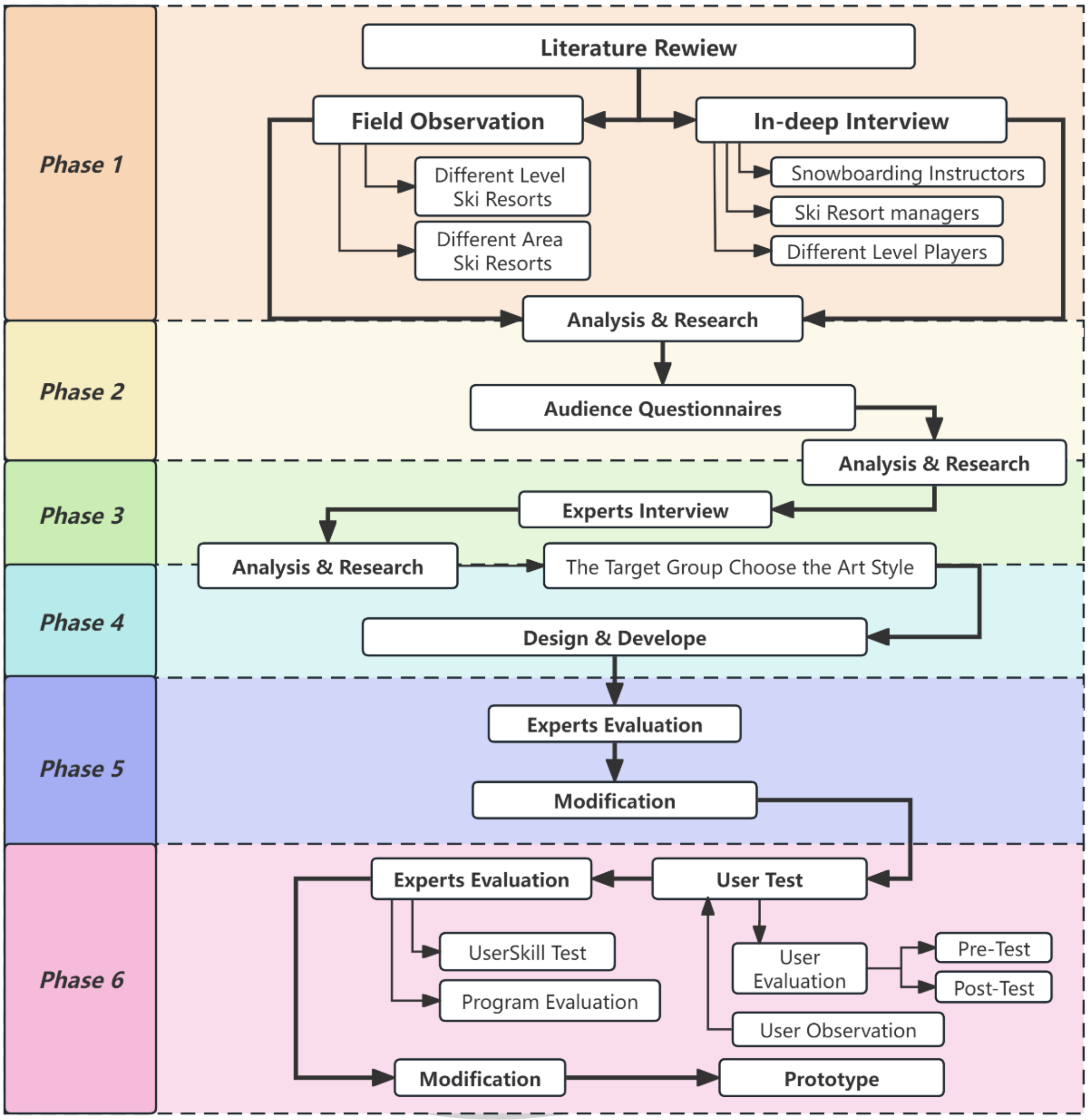
1.8 RESEARCH METHODOLOGY AND PROCESS OF STUDY

This study was a combined R&D effort, and the researchers divided it into six phases (Figure 2).

Phase 1: Through a literature review, the researchers identified and summarized the current status of snowboarding beginners. They conduct field observations at different levels of ski resorts in various regions to identify issues. In-depth interviews were conducted with snowboarding beginners, instructors, and operators to summarize the difficulties and challenges snowboarding beginners face. The analysis of these findings reveals snowboarding beginners' detailed educational experience needs for the first phase.

Figure 2

Research Methodology and Process of Study



Source: Created by the author

Phase 2: Based on the results of the first phase, the researchers designed a questionnaire for potential snowboarding beginners. This comprehensive survey gathers background information, experiences, expectations, and preferences of potential beginners. Analysis of the collected valid information leads to conclusions for the second phase.

Phase 3: The researchers conduct in-depth interviews with experts using the results from the second phase. The experts provide guidance and suggestions, evaluate the feasibility of the educational experience plan, and select appropriate technologies. The researchers designed an educational experience research framework for snowboarding beginners.

Phase 4: Before starting the design and development, researchers solicited opinions on the artistic style of the target users. The researchers designed and developed an educational experience research framework for snowboarding beginners. The design includes educational content and artistic elements from VR. Development involves modeling, scripting, optimization, and internet integration, resulting in Model 1.

Phase 5: The researchers invite relevant experts to evaluate the initial model. Based on the feedback, refine and iterate Model 1, leading to Model 2.

Phase 6: Model 2 undergoes user experience testing. Users evaluated Model 2 using questionnaires, and the researchers observed user behavior. Professional snowboarding instructors are evaluators in this phase, assessing users' skill levels and evaluating the model. Finally, the researchers summarized and analyzed all the evaluation results to provide suggestions for improvement, resulting in the creation of the final prototype.

1.9 DEFINITIONS OF SPECIFIC TERMS

"Edu-experience" denotes a combination of "Education" and "Experience," referring to an educational or learning process facilitated through direct experience and participation. This term emphasizes experiential, personal involvement, and interactive learning in educational contexts, aiming to enhance the depth of understanding and the longevity of learning outcomes. Within the realm of VR in snowboarding for beginners, edu-experience refers to a snowboarding experience created through VR technology, which aims to teach snowboarding skills and incorporates artistic elements to enrich and elevate the learning experience.

"Snowboarding Beginners" refers to individuals who aspire to try snowboarding but cannot because of insufficient time and financial resources. These individuals typically have to juggle work, family responsibilities, and a livelihood in their daily lives. Even if they occasionally have the opportunity to go snowboarding, their time may not be sufficient, so they only have brief experiences. Therefore, they require a method that enables them to quickly and effectively learn the basic snowboarding techniques at a minimum cost and in a more convenient learning mode, maximizing their learning outcomes and experience quality within the limited time available. This approach allows people to quickly become accustomed to snowboarding when visiting a ski resort, resulting in a better overall experience.

VR integrates comprehensive artistic expressions into VR technology to create immersive and interactive experiences that engage multiple senses. This involves using VR to simulate artistic environments or incorporating design elements into virtual experiences. It emphasizes the holistic combination of technology and artistry to enhance the aesthetic and emotional impact of VR content. VR also includes comprehensiveness, richness, engaging nature, and the ability to stimulate active participation through content design.

1.10 CHAPTER SUMMARY

This chapter discusses the key challenges faced by snowboarding beginners, particularly the high costs and difficulties associated with learning the sport. Despite the growing interest in snowboarding, driven by major events and social media, the chapter notes that many beginners are unable to fully engage in the sport due to financial costs, lack of time, psychological pressures, and the shortage of qualified instructors. Researchers have proposed VR as a potential solution to these challenges. By leveraging existing resources and optimizing the use of current technologies, VR can offer a cost-effective, flexible, and immersive learning experience. This approach not only meets the practical needs of beginners but also has the potential to innovate snowboarding education and contribute to the sustainable development of winter sports culture. This chapter identifies the pressing needs within the snowboarding community and proposes a technology-driven solution, laying the foundation for research that could transform how beginners learn and experience the sport.

CHAPTER 2

LITERATURE REVIEW

2.1 SNOWBOARDING AND SNOWBOARDING BEGINNER

2.1.1 THE DEVELOPMENT CONTEXT OF SNOWBOARDING

Snowboarding is a winter sport where people glide in snow. Snowboarding is an American sport that originated in the 1960s and evolved from surfing, water skiing, and skateboarding (Carlisle, 2009). Over time, snowboarding has been widely promoted and developed. The initial snowboarding design was mainly influenced by surfing. Early snowboards were similar to surfboards in terms of design and production, mainly using wood and fiberglass. However, as technology develops, modern snowboards use more advanced materials, such as polyurethane, carbon fiber, and polymer plastics (Lanfranconi, Vázquez, & Alvarez, 2012). In the early days of snowboarding, the lack of specialized training facilities and rules partly limited the development of snowboarding. Over time, in the 1980s, resorts began to embrace snowboarding, specialized training facilities, and competitions.

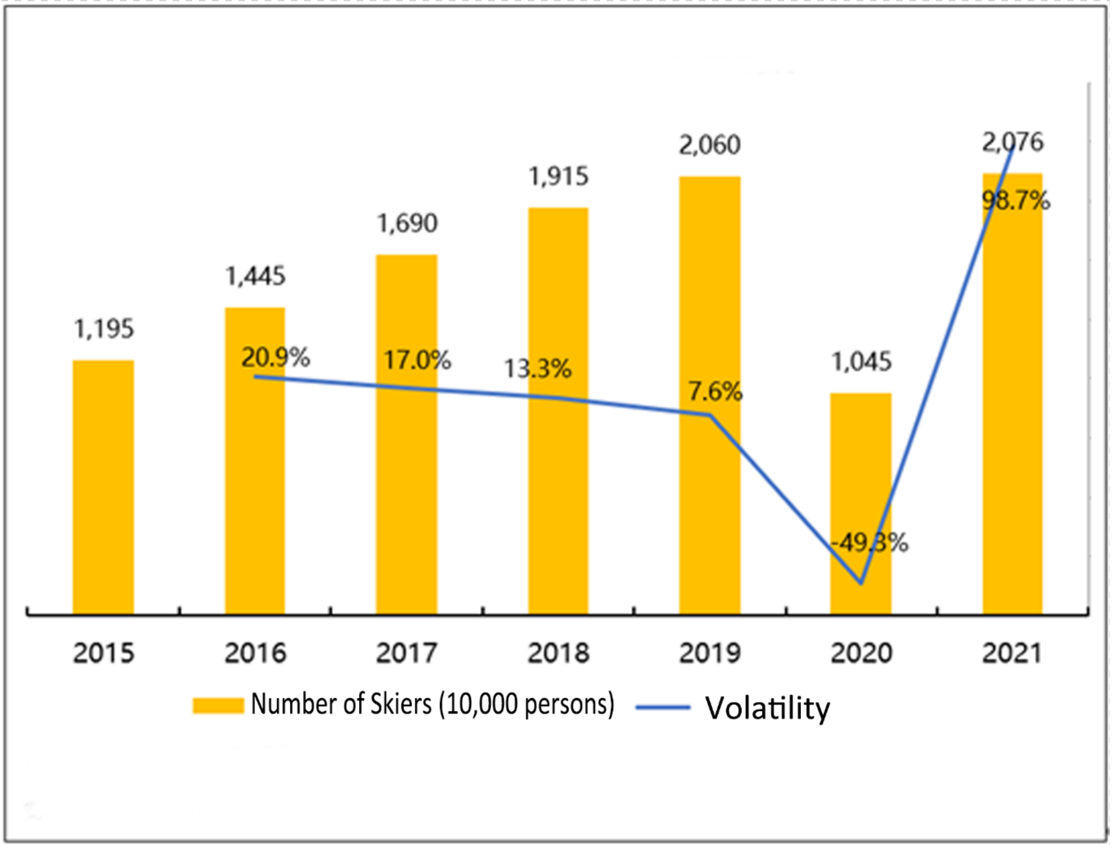
In 1985, the International Snowboard Federation (FIS) officially recognized snowboarding as an event, and the 1998 Winter Olympic Games officially listed it as an event, further popularizing and promoting snowboarding (Anderson, 1999). With the development of snowboarding, there are also various gliding styles and skills, such as freestyle, fancy, and speed. These styles and skills have their own characteristics, which makes snowboarding more ornamental and interesting. With further developments in technology, such as the application of VR, snowboarding is likely to become more diversified and popular (Heino, 2000). Snowboarding has evolved from a niche sport to a global sport, attracting a large number of snowboarders and spectators. It is not only a winter sport but also an art form that embodies individual skills and creativity. In the future, snowboarding is expected to become more diverse and interesting.

In snowboarding, everyone can develop their own unique style and skill (Thorpe, 2004). In addition to the various gliding styles and techniques, there have been many changes and innovations. For example, some people began to glide on semi-pipes to demonstrate their skill and boldness. At the same time, some people have started to play in the mountains and the wild to find more challenging venues. Snowboarding is an exciting and fun sport that can offer many enjoyable and challenging experiences. It is not only a sport but also an art form and cultural phenomenon, attracting an increasing number of young people and snowboarders (Coleman, 2004). The 2022 Beijing Winter Olympics were successfully held. The wonderful performances of stars Gu Ailing and Su Yiming on the field made snowboarding with unique sports experiences and strong social attributes quickly “out of the circle” and also made snowboarding training a hot spot (Wenao, 2023). The snowboarding craze has been going on ever since.

2.1.2 THE POPULARITY AND TREND OF SNOWBOARDING

The rapid popularization of snowboarding sports has led to an increasing demand for training (Baumgart & Ehrnthaller, 2020). Snowboarding is a dynamic sport that can provide exciting experiences for snowboarders and enhance their interest in ice and snow tourism. At the same time, snow friends have become a popular social activity (Neville, 2019). In recent years, as residents’ living standards gradually improved, snowboarding has increased; according to the “white paper on 2020 China snowboarding and skiing industry” data, by the end of April 2021, the national snowboarding and skiing of 20.76 million people, up 98.7%, 2015–2021 snow season (May 1 solstice on April 30), and the average annual compound growth rate of snowboarding people was 9.6% (Wu, 2020). Snowboarding needs certain skills; beginners need to be trained with the help of professionals, and the snowboarding training market will increase. In 2021, the per capita number of snowboarding and skiing in China was 1.91, and the mature market could reach more than four times. China's snowboard and ski market still has great potential for development, and snowboarding training has a large room for growth (Figure 3).

Figure 3
Snowboard and Ski Trips and Changes in China from 2015 to 2021



Note: from May 1 of the previous year to April 30 of the current year.
Source: 36Kr Research Institute. (2020). White Paper on China's Snowboard and Ski Industry 2020

With the development of sports habits of snowboarding experience people, the training industry will gradually be standardized and develop on a large scale. On the one hand, the wonderful performances of the athletes at the Beijing Winter Olympics will further drive the Chinese people's love for the snowboarding industry and promote the rapid development of the training industry (W. Chen, Zhou, & Bae, 2020).

On the other hand, the increase in the number and improvement of the quality of online snowboard training platforms will affect the younger generation in a wider range, promote the formation of their snowboarding consumption habits, and at the same time, it will break the information barrier between training institutions/trainers and consumers and make the snowboard training industry more standardized. The trend of increasing snowboard users and the standardized development of training services (W. Chen et al., 2020). China's snowboard training industry will continue to develop healthily.

As a popular extreme sport among young people, snowboarding has gradually developed from a niche sport to a popular sport around the world. Its popularity depends on its unique way of movement, the rich variety of skills and movements, and the unique culture behind it (Carlisle, 2009). In addition, snowboarding has many benefits for physical exercise, such as enhancing physical coordination and balance and improving heart and lung function (Coates, Clayton, & Humberstone, 2014).

Here are some more detailed advantages and developments of snowboarding:

The unique way of snowboarding, namely, sliding on snow mountains, attracts many young people looking for excitement and fresh experiences (Heino, 2000). This kind of exercise requires high coordination and a sense of balance and is challenging and enjoyable. When a skater completes a variety of difficult jumping and rotation movements on a snow mountain, the pleasure and sense of achievement are incomparable to other movements (Sulheim, Holme, Rødven, Ekeland, & Bahr, 2011). In addition, snowboarding can also exercise the body's endurance and muscle strength to improve cardiopulmonary function. Snowboarding involves a wide variety of skills and movements, making this highly ornamental. Both the variety of aerial skills on the halfpipe slide and the spectacular corners on the slopes have made snowboarding events a hit on TV and webcasts. In addition, snowboarders often share their snowboarding experiences and skills through photography and videos, further driving the popularity of snowboarding. It is believed that with the continuous progress and innovation of technology, more new skills and snowboarding movements will be developed in the future so that people can experience more fun. The unique culture of snowboarding is also an important factor in its popularity. Snowboarding originated from skateboarding and surfing, both of which carry a spirit of rebellion and freedom. This spirit has also been extended to snowboarding, forming a unique snowboarding culture. This culture emphasizes self-expression and respect for individual differences and encourages innovation and risk-taking. It is loved by young people and provides strong spiritual support for the popularity of snowboarding. In addition, with the popularity of snowboarding, an increasing number of people have begun to pay attention to environmental protection and sustainable development, and a low-carbon and environmentally friendly snowboarding culture has gradually formed.

2.1.3 THE INSTRUCTIONAL MARKET OF SNOWBOARDING

The goal of "300 million people on ice and snow" promotes the development of the snowboard training market. In 2015, China, in its Olympic bid to "drive 300 million people to participate in ice and snow sports" goal, developed the ice and snow sports development plan (2016–2025) (the word [2016] no. 645). This plan focused on the 2022 Beijing Olympics, promoted policies to establish schools with ice and snow sports programs, developed ice and snow sports teachers with an emphasis on teenagers, and promoted ice and snow fitness leisure projects (China, 2016). In this context, schools at all levels have strengthened their cooperation with training institutions, organized training and the selection of professional young snowboarders, and further expanded the snowboard training market through policy support.

Before the pandemic, the size of China's snowboard training market was expanding annually. In 2018, the market size reached 6.89 billion yuan, and the compound annual growth rate was 13.1% from 2014 to 2018 (China, 2022). In 2020, due to the impact of COVID-19, the market size declined slightly. However, with the rapid growth of China's snowboard trips combined with the snow and snow fever caused by the 2022 Beijing Winter Olympics, the snowboard training market will gradually heat up and enjoy long-term improvements (Figure 4).

Figure 4
Size of Snowboard and Ski Training Market in China in 2014–2020

Source: 36Kr Research Institute. (2020). White Paper on China's Snowboard and Ski Industry 2020

THE CHAIN STRUCTURE OF THE ICE AND SNOW TRAINING INDUSTRY

Upstream of the industry chain are hardware equipment, coaches, and other employees. Hardware equipment includes indoor and outdoor ski resorts, indoor analog snowboard machines, mobile snowboard platforms, artificial snow grass and other leisure equipment, snowboards, snowboard poles, snowboard clothing, protective gear, and other personal sports equipment. Coaches are the core link of the industrial chain and mainly provide action guidance, security, and other services.

Other employees include referees, ropeway technical workers, and operational and management personnel.

The middle reaches of the industrial chain include all levels of universities, training institutions, and online operation institutions. Universities that perform snow and ice training include Beijing Sport University, Shanghai Institute of Physical Education, and Shenyang Institute of Physical Education. The training institutions include provincial and college training teams for professional athletes, proprietary snowboard schools, and third-party snowboard schools for snowboarders. Online operators can provide online snowboarding tutorials, training channels, and coaching resources (Wu, 2020). The downstream of the industry chain is the user group, which includes professional athletes, snowboarders, and other occupations.

INVESTMENT AND FINANCING

Figure 5

List of Investment and Financing Events in the Snowboard Training Industry

Brand	Round	Disclosure time	Money	Capital	Company Introduction
Xueleshan	Strategic financing	2021-12	100 million RMB	Zheng Xin	Indoor snowbaording chain training instiution.
Huabei	A-wheel	2021-08	40 million RMB	Gaoling	Snowboarding mobile social platform, providing snowboarding video and online snowboarding teaching.
Snow 51	A+wheel	2021-04	10 million RMB	He Yu	Urban snowboarding one-stop space.
Go Ski	A+wheel	2021-02	20 million RMB	Heaven Silicon Valley	Snowboarding social platform, providing online snowboarding tutorials, training camps.
Yeti	Angel wheel	2020-12	1 million RMB	Qinggu Chuangye	Snowboard teaching service platform, providing channels for snowboarding training institutions, snow ticket purchasing services.

Source: 36 krypton, IT orange

According to 36 Kr and IT Orange data, there were 43 financing events in the ice and snow sports industry from 2013 to the end of 2021, among which the number of financing events in the snowboard training industry accounted for about 30%, and the total financing amount reached hundreds of millions of yuan. In terms of financing time, the snowboard training industry saw a peak between 2020 and 2021. From the perspective of types of financing projects, a one-stop snowboarding service platform that integrates online and offline is favored by capital (Figure 5).

At present, China's snowboarding training industry is still in the early stage of development (Chengcai, Rui, Yuanyuan, Shiyi, & Xin, 2022). From the supply side, some coaches lack professional certification, the training service course system is not perfect, and the degree of localization is not enough, which restricts the large-scale development of the industry to a certain extent. From the demand side, the price of snowboarding training is high, and the scale of the participants is limited (Liang, 2019). Consumers also mainly focus on experience.

2.1.4 GENDER AND AGE DISTRIBUTION OF SNOWBOARDERS

The age distribution for snowboarding players indicated that most were between 26 and 40 years old. Specifically, 9.8% of participants are aged 18–25, 38.2% are aged 26–30, and 45.5% are aged 31–40, making this the largest group. Participants aged 41–50 account for 4.9% of the total, whereas only 1.6% were 50 and above. These data show that the most common age range for snowboarders is 2640 years (Information, 2021). According to the "New Generation New Circle 2021 Vertical Circle Marketing Research Report," the gender distribution of snowboarders shows a notable difference between male and female participants. Males constituted 61.8% of the total population, indicating a majority of this group. In contrast, females constituted 38.2% of the participants. Although male users still dominate the smartphone market, the number of female users has increased rapidly in recent years (Information, 2021).

2.1.5 PHYSICAL FITNESS AND TRAINING REQUIREMENTS FOR BEGINNERS

Snowboarding is a difficult sport that requires physical strength and skill and is suitable for beginners. Snowboarders suffer frequent sports injuries, and the necessity of training is high. Snowboarding has a certain risk, in the absence of systematic training in snowboarding, of easily causing sports injuries and even life-threatening (Machold, Kolonja, Kwasny, & Fuchs, 1999). High-quality systematic training can effectively reduce the rate of sports injury and greatly reduce the difficulty of treatment after injury (Schoeb et al., 2022). In addition to requiring a certain amount of muscle strength and endurance, especially in the legs and core muscles, they are also needed to control the direction and speed of the snowboards and maintain the balance of the body (Stepan, Scher, Ruedl, & Shealy, 2023). Moreover, when snowboarding at higher altitudes, the oxygen content is lower; therefore, cardiopulmonary function is higher. All these require beginners to be fully prepared in terms of physical aspects.

Sports experience is another factor to consider. For people without athletic backgrounds, there may be some challenges in learning snowboarding. However, if you are experienced in skateboarding, surfing, or snowboarding, these skills may help you master snowboarding faster. This is because each exercise requires similar balance skills and physical coordination. Therefore, beginners can extend and expand their previous sports experience (Brunner, Ruedl, Kopp, & Burtscher, 2015).

Before starting to learn snowboarding, it is recommended that you perform some physical training, such as strengthening the core muscles and improving cardiopulmonary endurance. This will not only help you learn to snowboard faster but also reduce the risk of injury (Ruedl et al., 2013). At the same time, beginners do not try to master all the skills at once; they should start from the most basic skills to gradually learn and master them to better enjoy the fun of snowboarding.

2.1.6 PRINCIPLES OF SNOWBOARDING SKILLS AND METHODS

The act of snowboarding down a slope involves balance, coordination, and the application of fundamental physical laws. Newton’s three laws of motion play a crucial role in this process. The law of inertia states that a snowboarder remains at rest or in motion unless acted upon by an external force, with gravity being the primary force. Gravity is divided into a normal force that pushes the snowboarder downhill and a component force parallel to the slope that accelerates the snowboarder downhill. According to the law of action and reaction, the normal force is balanced by the reactive force from the slope. As the slope steepens, the component force increases, leading to more excellent acceleration down the hill. Newton’s second law explains that the snowboarder’s acceleration increases as the parallel force grows on steeper slopes (Thorpe, 2012). The most important skill to master in snowboarding is edge control. By controlling the edges, players control their speed and direction (Althen, 2015). The snowboard uses the shoulders to control the direction of motion, not the hips. Players can work on their posture at home or elsewhere. When snowboarders match their stance width with their natural walking stride, the transition to maintaining balance on the snowboard becomes smoother. Since individuals are accustomed to balancing with a specific stride width during daily walking, aligning their snowboard stance with this natural stride allows them to more easily transfer the balance they have developed in everyday life to snowboarding, thereby enhancing stability while riding (Martin, 2007). Therefore, it opens up the possibility of practicing snowboarding skills when snowboarding is not an applicable skill.

2.2 EDUCATIONAL EXPERIENCE

2.2.1 DEFINITION OF EDUCATIONAL EXPERIENCE

Educational experience refers to the comprehensive experience that individuals gain through their participation in educational activities, including knowledge acquisition, skill development, emotional experiences, and personal growth. This concept emphasizes not only the transmission and reception of educational content but also the subjective experiences and individual differences of learners in the educational process (Gimbert, Miller, Herman, Breedlove, & Molina, 2023; Leung, 2013).

In the educational experience, "content and environment" are critical elements that influence learning efficiency and motivation. Educational content includes knowledge points, concepts, theories, and practical operations, which are carefully selected to align with teaching objectives and meet learners' needs. The content depth should match the learners' prior knowledge and abilities, offering basic knowledge for beginners and in-depth analysis for advanced learners (Yu, Gao, & Wang, 2021). Educational materials include traditional textbooks and modern multimedia resources such as videos, audio, and interactive software. High-quality materials provide accurate information and are designed to be engaging and easy to understand, often using graphics and animations. Virtual tools like simulators and virtual labs offer practical experiences that enhance theoretical learning (Merchant, Goetz, Cifuentes, Keeney-Kennicutt, & Davis, 2014). The learning environment can be physical or virtual. Physical environments, such as classrooms and laboratories, support face-to-face interactions and teamwork, while virtual environments offer flexibility and accessibility, enhancing learning through simulation and gamification. The environment should support teaching objectives with appropriate technical support, comfortable layouts, and conducive atmospheres for concentration (Martín-Gutiérrez, Mora, Añorbe-Díaz, & González-Marrero, 2017). Effective design and integration of content, materials, and environments can significantly improve educational quality and foster learners' overall development.

Emotions and attitudes are crucial to education, directly impacting learners' engagement, persistence, and outcomes. Learners' interest in content drives active engagement and deep learning. Teachers can stimulate this interest by connecting content to life experiences, using multimedia, and designing engaging activities. Joy in learning stemming from smooth experiences, success, and effective interactions enhances efficiency and outcomes. Positive emotions can be fostered through reasonable challenges, positive feedback, and supportive environments (Pekrun & Linnenbrink-Garcia, 2012). Setbacks in learning are inevitable. Teachers should teach coping strategies, provide emotional support, and promote a culture that values effort over results. Management of frustration is essential for maintaining motivation. Educational experiences generally influence learners' attitudes toward subjects and learning. Positive experiences build confidence and enable independent learning skills, whereas negative experiences can cause resistance (Sinatra, Heddy, & Lombardi, 2015). Educators should focus on learners' emotions and attitudes and design strategies that create positive, inclusive, and motivating environments. This approach promotes holistic development and long-term learning.

Cognition and thinking are central to education, involving processes such as memory, attention, understanding, analysis, evaluation, creation, and problem-solving. Education begins with understanding and memorizing new knowledge, which can be enhanced through examples, repetition, and practice. Critical thinking, the ability to evaluate information and form logical judgments, is fostered by encouraging questions, analysis, and debates (Glaser, 1984). Creative thinking is stimulated by open questions, diverse perspectives, and interdisciplinary learning, which affords learners the opportunity to generate novel ideas. Problem-solving skills are developed by simulating real-world situations, allowing learners to apply theoretical knowledge and improve their practical skills. Balancing these cognitive and thinking skills in educational activities enhances learners' academic performance and their ability to cope with daily life and their future careers, thus promoting comprehensive psychological development (Runco & Chand, 1995).

Behavior and performance are crucial to education, focusing on how learners apply knowledge and skills and form new habits. Education enables learners to use their skills in real-world situations, such as applying teamwork skills from simulations to the workplace. Effective education encourages behavioral adjustments, fostering active learning and self-directed attitudes. Habit formation, such as regular review and critical thinking, requires continuous practice and positive reinforcement. Teachers can support this through stable learning environments and motivation (Orn, 2022). Regular assessments and feedback are used to track progress and adjust strategies. By focusing on behavior and performance, education supports comprehensive learner growth and long-term educational goals.

Educational experiences have a profound impact on learners' personal growth. This not only shapes learners' understanding and interest in a specific subject but also influences their career development and life choices (Dewey, 1986). The quality of an educational experience can determine learner motivation, willingness to continue to learn, and ultimately learning outcomes (Buchmann & Schwille, 1983). The optimization of educational experiences usually requires teachers to innovate teaching strategies, such as adopting more attractive teaching materials, increasing learners' engagement, and creating more supportive learning environments (Mincer, 1975). When designing educational activities, learners' needs and contexts should be considered to provide a more personalized and meaningful learning experience (COHN, 2005).

2.2.2 STRATEGIES TO IMPROVE EDUCATIONAL EXPERIENCES

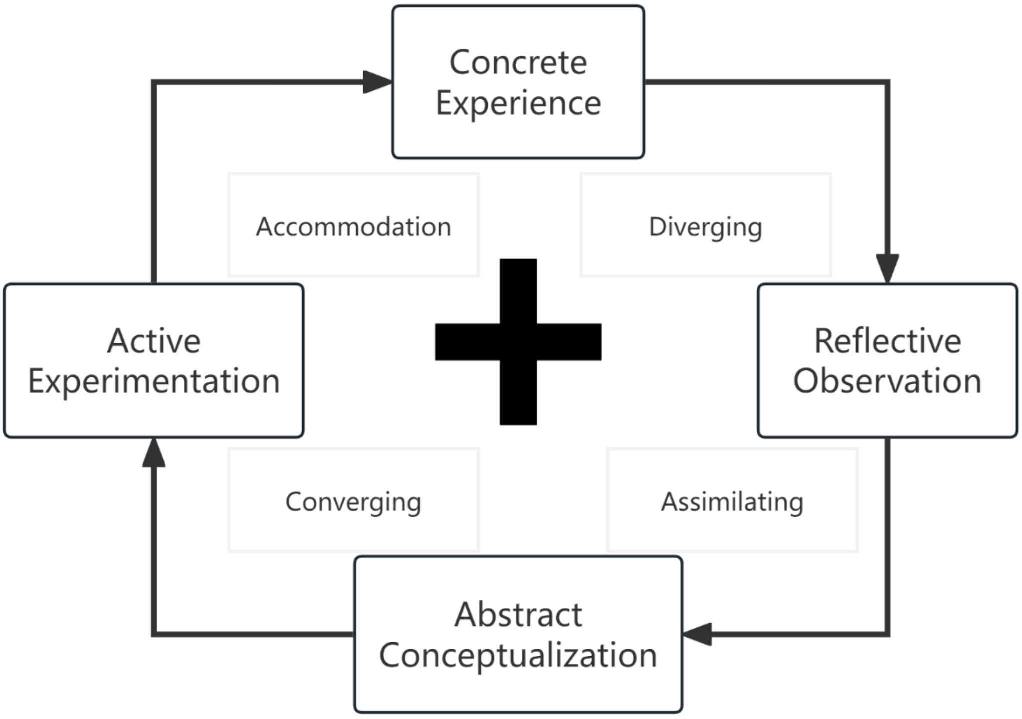
This section discusses several evaluation models applicable to education and experience. These models measure and improve various aspects of the learning process, including students' knowledge acquisition, skill development, emotional experiences, and personal growth. By analyzing these evaluation models, researchers can better understand which teaching strategies and learning environments are most effective in enhancing educational quality. These models also help educators identify and address issues in the learning process, providing more personalized and meaningful educational experiences.

2.2.2.1 REGARDING EDUCATIONAL MODELS AND THEORIES

1) Kolb's Empirical Learning Theory

John Dewey emphasized that although not all experiences are equally educational, true education is rooted in experience (Figure 6). To be effective learners, individuals need four distinct abilities: concrete experience, reflective observation, abstract conceptualization, and active experimentation. They must engage fully and openly in new experiences, reflect on and observe these experiences from various perspectives, create concepts, integrate their observations into coherent theories, and use these theories to make decisions and solve problems. This process involves a four-stage cycle in which learning emerges from resolving the creative tension between the adaptive learning modes. It is depicted as an idealized learning spiral where learners engage in experience, reflection, thinking, and action, continuously adapting to the learning context and content (Akella, 2010).

Figure 6
Kolb Study Experience Theory



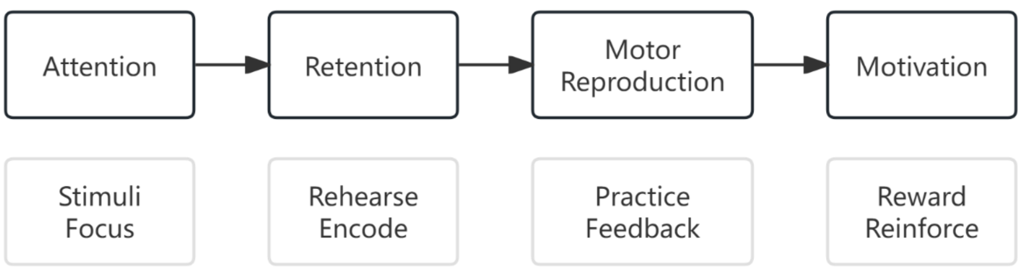
Source: Drawn by the author based on Kolb Study Experience Theory

The application of Kolb's Empirical Learning Theory in physical education is because the cyclic and experience-led characteristics of this theory coincide with physical training and teaching practice. In sports, the acquisition and improvement of skills often require practice, reflection, theoretical construction, and re-practice (Manolis, Burns, Assudani, & Chinta, 2013).

2) Albert Bandura's Social Learning Theory

Albert Bandura's Social Learning Theory, later known as Social Cognitive Theory, posits that people learn within a social context through observation, imitation, and modeling (Figure 7). Developed in the 1960s and 70s, the theory highlights key components: observational learning, where individuals learn by watching others; attention, which is necessary to focus on the observed behavior; retention, involving the ability to remember the behavior; reproduction, the ability to imitate the behavior; and motivation, which drives the actual imitation, influenced by rewards and punishments. Additionally, Bandura introduced the concept of self-efficacy, referring to individuals' belief in their capability to perform a task, which affects their motivation and outcomes. This theory has broad applications, including education and mental health, and it was famously demonstrated in Bandura's "Bobo doll" experiment that illustrated how children can learn aggressive behaviors by observing violent models (McLeod, 2011).

Figure 7
Albert Bandura's Social Learning Theory



Source: Drawn by the author based on Albert Bandura's Social Learning Theory

The Social Learning Theory proposes that individuals learn through observation, imitation, and reinforcement. According to the theory, there are four stages of social learning:

Note: At this stage, individuals must first pay attention to the behavior they observe. This requires attention and focus on the behavior of the model.

Retention: At this stage, individuals must remember the behavior they have observed. This involves both cognitive processing and memory storage.

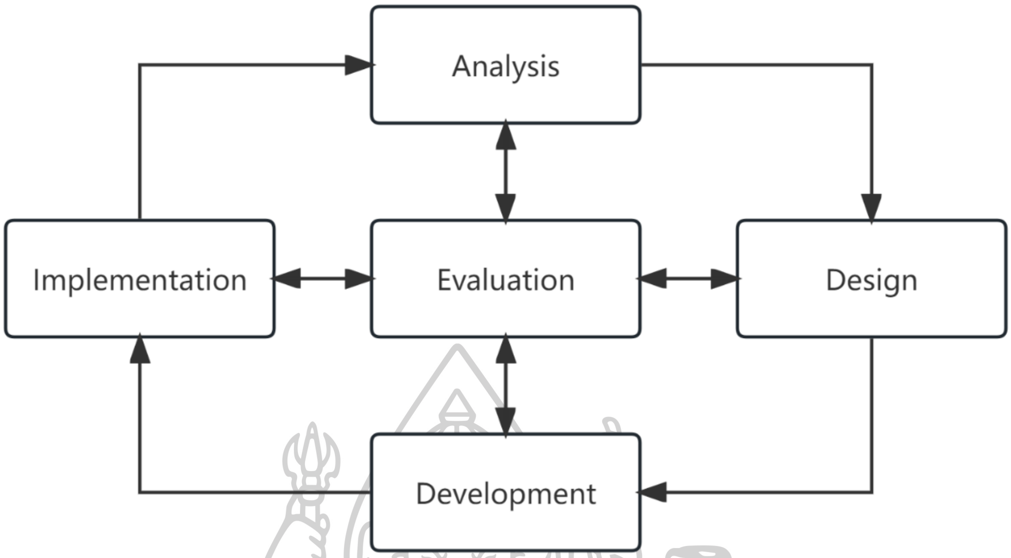
Reproduction: At this stage, individuals attempt to replicate their observed behavior. This may involve practicing and perfecting the behavior until it can be performed accurately.

Motivation: At this stage, the individual must have a reason or motivation to perform the act. This may involve reinforcement, punishment, social recognition, disapproval, or other incentives.

3) ADDIE Learning Models

The ADDIE Learning Model is a systematic framework for instructional design that includes five phases: Analysis, Design, Development, Implementation, and Evaluation (Peterson, 2003). The process begins by identifying learning needs and defining instructional goals, then planning instructional strategies and creating detailed blueprints. The development phase involves producing educational materials and integrating technologies. Implementation focuses on delivering an educational program and ensuring smooth instruction. Finally, throughout the process, evaluation formally assesses the program's impact and effectiveness, using feedback to make necessary adjustments and improvements (Branch, 2009). This iterative approach ensures that educational experiences are effective, efficient, and aligned with learners' needs (Figure 8).

Figure 8
The ADDIE Learning Model Conceptual Framework



Source: Drawn by the author based on the ADDIE Learning Model Concept

Comparison: Approach to Learning: Kolb focused on learning through experience, Bandura on learning through social interaction, and ADDIE on systematic instructional design.

Structure: Kolb's and Bandura's theories are more conceptual and descriptive and explain how learning occurs. ADDIE is prescriptive, providing a step-by-step process for creating instructional materials.

Phases/Cycles: Kolb's Model is cyclical and iterative, Bandura's Model is based on stages of social learning, and ADDIE is a linear yet iterative process with distinct phases.

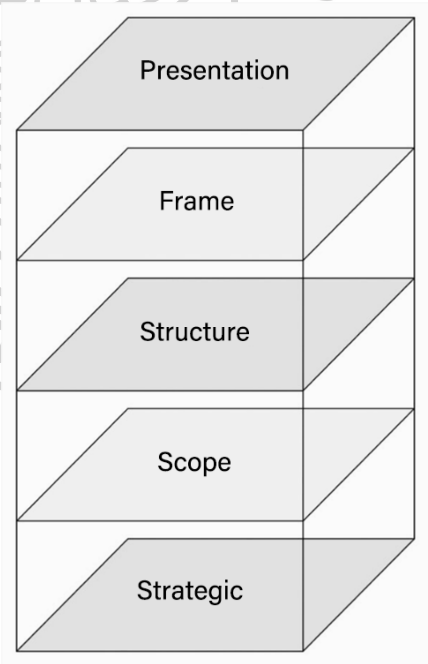
Application Contexts: Kolb is suitable for experiential and hands-on learning, Bandura is suitable for environments that leverage social learning, and ADDIE is suitable for structured instructional design and development.

2.2.2.2 REGARDING USER EXPERIENCE MODELS AND THEORIES

1) Jesse James Garrett's Five-Tier User Experience Model

Jesse James Garrett's Five-Tier User Experience Model, described in his book "The Elements of User Experience," provides a robust framework for evaluating educational experiences (Figure 9). This model encompasses the strategy layer (focusing on learner needs and educational goals), scope layer (defining content and functional requirements), structural layer (organizing content and interaction), frame layer (designing clear and intuitive interfaces), and performance layer (visual design). By applying this model, one can comprehensively assess whether educational designs meet learning objectives, facilitate effective navigation and interaction, and create an engaging and motivating visual environment for learners (Garrett, 2006).

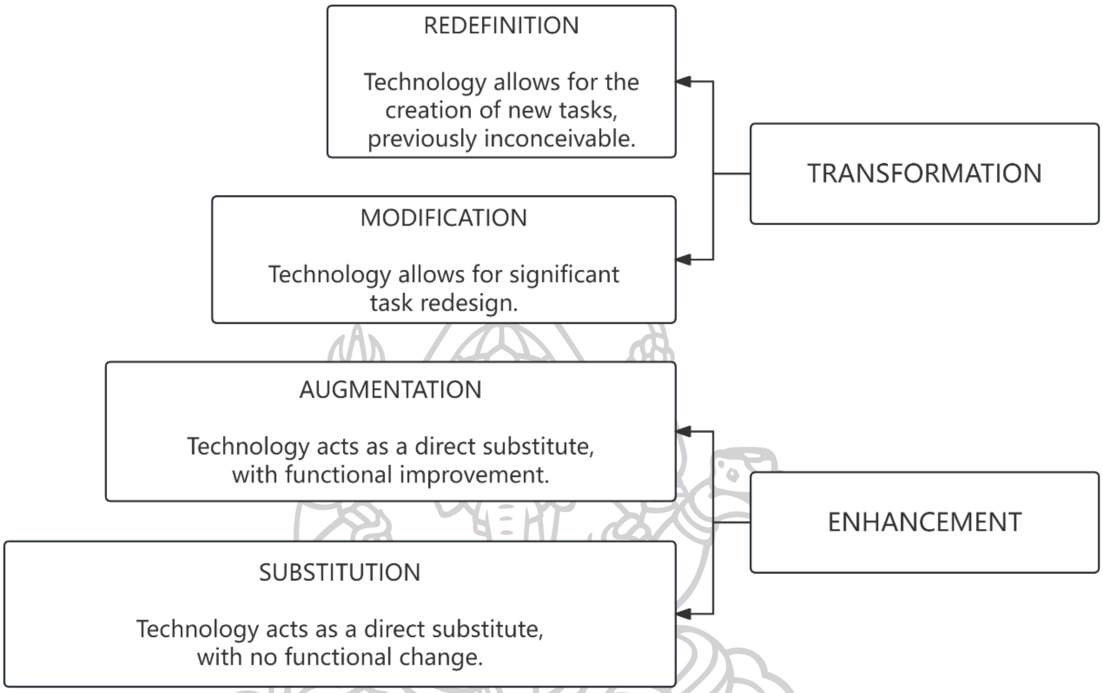
Figure 9
Five Levels of User Experience Elements Conceptual Framework



Source: Drawn by the author based on the Five Levels of User Experience Elements Conceptual Framework

2) SAMR Model

Figure 10
SAMR Conceptual Framework



Source: Drawn by the author based on the SAMR Model Concept

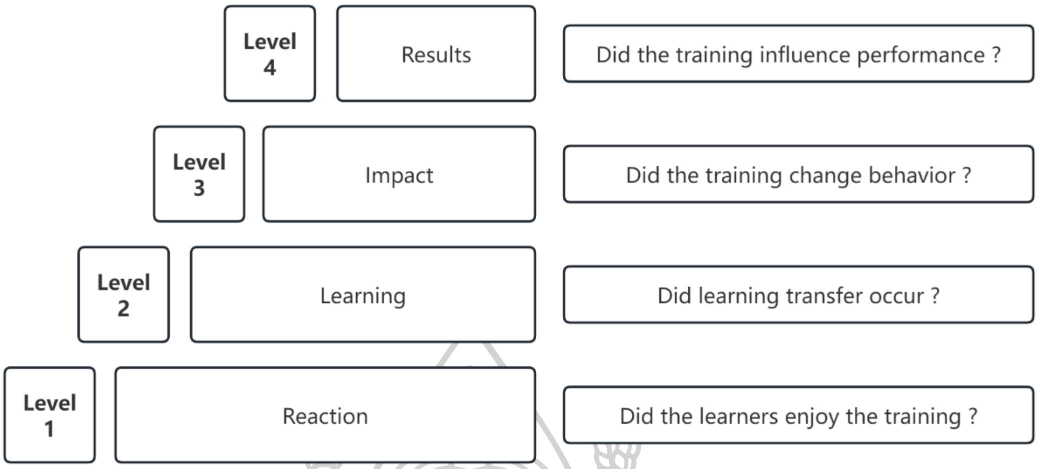
The SAMR Model, developed by Dr. Ruben Puentedura, is a framework designed to help educators integrate technology into teaching and learning, encompassing four levels: Substitution, Augmentation, Modification, and Redefinition (Romrell, Kidder, & Wood, 2014). The proposed technology acts as a direct tool substitute at the Substitution level with no significant change in functionality. Augmentation enhances a task by adding functionalities that improve the learning experience (Blundell, Mukherjee, & Nykvist, 2022). Modifications allow for significant task redesigns, enabling new ways to complete assignments. Redefinition transforms the learning experience entirely by creating new tasks that were previously inconceivable (Hamilton, Rosenberg, & Akcaoglu, 2016). The SAMR Model encourages educators to progress from merely enhancing traditional tasks to fundamentally transforming them and promoting higher-order thinking, creativity, and collaboration (Caukin & Trail, 2019). This approach effectively improves student engagement and learning outcomes by leveraging technology. However, successful implementation requires adequate training, resources, and thoughtful assessment to evaluate the impact on learning (Figure 10).

3) Kirkpatrick Model

The Kirkpatrick Model, developed by Dr. Donald Kirkpatrick, is a comprehensive framework for evaluating the effectiveness of training and educational programs through four distinct levels (Cahapay, 2021). The first level, Reaction, measures participants' initial responses, including their satisfaction, engagement, and perceived material relevance (Smidt, Balandin, Sigafoos, & Reed, 2009). The second level, Learning, assesses how participants acquired the intended knowledge, skills, and attitudes using pre- and post-training assessments, tests, and practical demonstrations (Panchenko, 2013). The third level, behavior, evaluates changes in participants' behavior and the application of new skills in real-life settings through observations, performance evaluations, and interviews (Paull, Whitsed, & Girardi, 2016). The final level, Results, measures the overall impact of the training on organizational goals, such as increased productivity, improved quality, reduced costs, and enhanced customer satisfaction, often using business metrics and ROI analysis (Kirkpatrick, 2015; Tamkin, Yarnall, & Kerrin, 2002). This model provides a holistic view of training effectiveness, facilitating continuous improvement and ensuring alignment with organizational objectives; however, it requires significant resources and thorough data collection for comprehensive evaluation (Figure 11).

Figure 11

The Kirkpatrick Model Conceptual Framework



Source: Drawn by the author based on the Kirkpatrick Model

These three models each have distinct applications and objectives. The Kirkpatrick Model is used to evaluate the effectiveness of training programs, measuring their impact on individuals and organizations through four levels: reaction, learning, behavior, and results. The SAMR Model focuses on the integration of technology in education, aiming to enhance and transform learning experiences through four levels of technology application. The Five-Tier User Experience Model, on the other hand, is centered on digital product design, addressing various aspects from strategy to visual design to create user-centered, effective, and engaging digital experiences. Each model provides a structured approach to achieving its specific goals. The researchers compared the evaluation models as follows (Table 1):

Table 1
Comparison of Evaluation Models

	Kirkpatrick Model	***SAMR Model***	***Five-Tier User Experience Model***
Purpose and Context	The evaluation of the effectiveness of training programs.	Centers on integrating technology into educational practices.	Geared toward designing comprehensive user experiences for digital products.
Structure and Levels	Reaction, learning, behavior, and results.	Four levels focusing on the degree of technology integration.	From strategy to visual design, covering all aspects of digital product design.
Focus and Outcomes	Aims to measure and improve the impact of training on individuals and organizations.	Aims to enhance and transform learning experiences through technology.	Aims to create effective and engaging digital experiences by addressing all design layers.
Application	Applied in training and educational program evaluation.	Applied in educational settings to integrate technology.	Applied in digital product design to create user-centered experiences.

Source: Compiled by the author

2.2.2.3 USER-CENTERED DESIGN

User-centered design (UCD) is a design philosophy and process that places the end user at the core of product and service development. Its primary objective is to create solutions that align with user needs, preferences, and limitations (Abras, Maloney-Krichmar, & Preece, 2004).

The UCD process includes stages such as research and analysis, where designers conduct user research to gather information about user needs and behaviors and create personas and scenarios to guide design decisions. The design stage involves brainstorming, prototyping, and structuring information in a user-friendly manner. During evaluation, usability testing and feedback analysis were conducted to iteratively refine the design. The implementation stage translates the refined design into a functional product, providing user training and support. Finally, post-launch evaluation involves monitoring user interactions and feedback to make further enhancements. The benefits of UCD include enhanced usability, increased user satisfaction, reduced development costs due to early issue identification, and improved accessibility. Overall, UCD emphasizes a comprehensive approach focusing on understanding and addressing user needs throughout the design process, leading to functional, efficient, and enjoyable products.

2.3 APPLICATION AND POTENTIAL OF VIRTUAL REALITY IN EDUCATION

2.3.1 CONCEPT AND DEVELOPMENT PROCESS OF VIRTUAL REALITY TECHNOLOGY

2.3.1.1 CONCEPT OF VIRTUAL REALITY

VR is a technology based on computers and advanced electronic technology (Burdea & Coiffet, 2003). The technology was first introduced by Joe Lanier of the United States in the early 1980s (Wohlgenannt, Simons, & Stieglitz, 2020). Its core idea is to take computer technology as the core, combined with other related science and technology, and generate a highly similar digital environment to the real world in terms of vision, listening, touch, and other aspects (Biocca, 1992).

In a VR environment, people interact with a digital environment through specific interactive devices, which can produce a real-world experience (Greengard, 2019). The device can be a head-mounted display, a glove, or any other form of interface, and the goal is to allow users to sense and operate in a virtual environment.

There is currently no unified standard for the definition of VR technology. In a narrow sense, VR technology represents an advanced form of human-computer interaction. In a broad definition, VR technology involves the simulation of virtual imagination (three-dimensional visualization) or a real, multisensory, three-dimensional virtual world (Brooks, 1999). In this case, VR technology is called a “nature-based human-machine interface.”

The key feature of VR technology is that it can use computers to generate an analog environment (such as an aircraft cockpit, operation site, etc.), “input” the user through a variety of sensing devices, and realize direct natural interaction between the user and the environment. The naturalness of this interaction is the greatest difference between VR technology and other types of user interfaces (Vince, 2004).

VR technology has a wide range of applications, ranging from education and training to design and manufacturing and entertainment and gaming. For example, in the medical field, VR technology can be used to simulate surgery, allowing doctors to practice surgical technology in a risk-free environment; in the aviation field, VR technology can simulate the cockpit of aircraft and pilot flight training; in the game field, VR technology brings new game experiences, and players can truly feel themselves in the game environment and achieve an unprecedented immersive experience (Velev & Zlateva, 2017). VR technology is also exploring more use possibilities (Yoh, 2001). For example, it can be used in the real estate industry, allowing potential buyers to experience the housing environment in detail before buying; in psychotherapy, it can be used to help people face and overcome the fear of heights and flight. Even news reporting can help people more intuitively understand and feel the reported events (Helsel, 1992).

VR technology also faces some challenges. The primary cause of these problems is probably hardware limitations. Current VR devices often require expensive hardware support and require users to wear helmets and other devices, which limits the popularity of VR to some extent. In addition, VR technology has much room for improvement relative to providing a realistic user experience (Yoh, 2001). For example, users can better simulate the touch and avoid vertigo and other discomforts (Heim, 1995).

2.3.1.2 MAIN CHARACTERISTICS OF VIRTUAL REALITY TECHNOLOGY

VR technology provides a way to simulate a real-world environment or a completely fictional environment in which users can interact. The main features of VR are as follows (Table 2).

These features are key factors that distinguish VR technology from other digital technologies and are why VR has become so attractive in entertainment, healthcare, education, engineering, and many other fields.

Table 2

The Main Characteristics of VR Technology

Feature	***Description***
Immersion	A core feature of VR technology is that it provides a highly immersive experience, allowing the user to feel completely in a different environment. VR headsets allow the user to view a three-dimensional virtual space from all directions.
Interaction	Users can not only observe the virtual environment but can also interact with it. Interaction with hand tracking, handles, touch pads, gloves, and other devices.
Reality	To make the experience more realistic, VR technology ensures that graphics, sound, and tactile feedback are as close to the real world as possible.
Three-dimensional	Unlike traditional 2D screens, VR provides users with a realistic sense of 3D space.
Space sense (3D Perception)	With a stereoscopic view, users can clearly perceive the depth, size, and position of the object.
User Center	The VR experience is completely user-centric, which means that when a user moves or views a virtual world, it adjusts accordingly to its Angle and position.
Dynamic Environment	The virtual environment can change in real time according to user interactions or preset logic.
Body Tracking	Many advanced VR systems can track the movements of the head, hand, or body in real time in a virtual environment.
Multisensory Experience (Multisensory Feedback)	Although the current VR experience is primarily visual and auditory, with the advancement of technology, more sensory experiences, such as touch and smell, are also being studied.
Autonomy	Users can make decisions and choices in the VR environment, which can affect their experience or the state of the virtual environment.
Continuity	VR experiences typically provide users with a continuous, seamless switching environment, which enhances immersion.

Source: Compiled by the author

2.3.1.3 THE DEVELOPMENT AND APPLICATION OF VIRTUAL REALITY

The function of VR is first to provide participants with a more realistic experience. This real experience is a sense of immersion or engagement in which participants fully engage in the virtual environment created by VR and hallucinate in the virtual world. Ideally, it should be more realistic than the reality of the real world. The primary goal of this immersion is to get the customer focused. At present, in the military, medicine, film, television, and other fields, the integration of these disciplines with education and teaching is increasing (Du, 2021). VR technology has strong interactions and can quickly integrate with various fields.

VR is a simulation environment created by computer technology that users can interact with. Based on its immersion, interactivity, and authenticity, VR can be classified into several categories (Wohlgenannt et al., 2020). Here are the main types of VR (Table 3).

As technology advances, these classifications may change. However, so far, these are the main types of virtual reality technology. VR and MR technologies are considered technological breakthroughs that facilitate learning. The research and application of VR/MR technology in education have enriched the forms of teaching and learning that are currently used in educational strategies (Kamińska et al., 2019). A virtual learning environment (VLE) not only provides a rich teaching mode and teaching content but also helps improve learners' ability to analyze problems and explore new concepts. Combining the advantages of immersion, interactivity, and imagination, this approach builds a shared virtual learning space accessible to learners living in virtual communities (Pan, Cheok, Yang, Zhu, & Shi, 2006).

Table 3

Types of VR and Related Technologies

Type	***Description and Characteristics***
Fully Immersive VR	The user is completely immersed in a computer-generated three-dimensional environment. Use high-end VR headsets, such as the Oculus Rift, HTC Vive, and Valve Index. Provides high resolution, high frame rate, and high interactivity. Additional sensors or devices may also be required to track user body movements.
Non-fully Immersive VR	Users are partially immersed in a virtual environment. No special headset is required; users often use a normal computer screen and other input devices. Driving and flight simulators are common examples of such simulators.
Semi-immersive VR	Combining fully and non-fully immersive features. Users will experience a virtual environment in front of a large projection screen, such as an immersive display wall. It can track certain user movements, such as the movements of the head and hands.
Augmented Reality	AR is not entirely VR; however, they have overlapping parts. AR is the superposition of computer-generated images or information in the real world. Experience it with smartphones, tablets, or augmented reality glasses (such as Microsoft's HoloLens).
Mixed Reality	Combining the characteristics of AR and VR. Can interactively stack and manipulate virtual objects in the real world. Microsoft's HoloLens is an example of an MR.
Social VR	Virtual environment designed for social interaction. Users can interact with others in VR, such as Facebook Horizon or VRChat.
Web Page VR	Allows developers to create immersive VR and AR experiences for the browser. Users do not need to download specific applications; they simply access VR content using a compatible browser.

Source: Compiled by the author

Digital game learning is an effective method for enhancing students' motivation and improving their academic performance. Many educational computer games have been developed in recent years to facilitate learning across various subjects, such as mathematics, natural sciences, social sciences, and engineering. These games have shown promise in increasing students' interest and motivation in learning by providing a more engaging and challenging environment than traditional instructional methods. However, some studies have noted that the impact of educational computer games may not be as significant as expected. Consequently, developing such games using effective learning strategies, knowledge-building tools, and educational theories has become crucial s (N.-S. Chen & Hwang, 2014). A key finding is that more than simply incorporating digital games into education is needed; successful digital game learning environments require well-designed learning strategies and tools and the integration of learning objectives and content with game tasks and scenarios.

In design teaching, the rapid development of the Internet and multimedia applications has led to new teaching methods and media, with VR technology emerging as a significant innovation. Traditional methods of creating and expressing environmental design no longer suffice in the digital age, necessitating the integration of new technologies like VR to enrich and expand the field. This paper explores VR technology as a new educational tool, proposing a new research area in educational technology—VR technology teaching. By studying the types and characteristics of VR technology and its practical teaching applications, the concept of desktop VR is introduced for use in experimental model-making courses. This approach aims to construct a virtual learning environment replicating real-world knowledge generation, allowing students to use sensory information to enhance their interest, creativity, and imagination while reducing hardware costs and improving learning outcomes. Now mature and widely applicable, VR technology helps designers observe and interact with the world, inspires new ideas, expands design methods, and enhances creativity from the initial design to the final presentation. In design teaching, VR technology requires students to develop three-dimensional spatial analysis skills, ultimately making environmental design more human-centered (Du, 2021). Giving full play to their respective advantages can broaden teachers' teaching horizons, expand teaching spaces, and expand teaching resources. Virtual teaching permeates time- and fixed-point teaching methods in traditional teaching methods and is adopted in simulation scene teaching. Virtual teaching can not only provide related products and services for teaching but can also enable education to develop in a better direction.

With the spread of consumer VR technology and reduced costs, immersive educational and training opportunities have expanded significantly. While previously limited by technology and cost constraints, VR is now being recognized by educational institutions and industries as a critical training tool. This technology allows trainees to train, explore, and test themselves in safe environments, which is especially valuable in high-cost or high-risk scenarios. VR in education and training faces technical and implementation challenges. Traditional field training has several issues, such as production losses, potential injury risks, and the inability to simulate natural work environments accurately (Carruth, 2017). Reproducing specific emergencies and environments for training is challenging, and real-world training may not effectively assess employee performance and stress levels.

As a high-technology, computer-aided technology based on VR has been widely used in science and technology, medical care, national defense, military affairs, and many other fields. In recent years, with the continuous advancement of educational reform, the art education curriculum in primary and secondary schools has gradually introduced advanced science and technology. Through the use of VR technology and school education, the disadvantages of the simple retelling and mechanical reproduction of traditional art teaching. It is a multi-structure teaching mode that combines art teaching theory with computer digital multimedia technology to create a new method of art teaching based on computer assistance. The new model applies the advantages of computer technology to art education, promotes the orderly development of art education, and improves the professional learning level of art educators and learners (Feng & Zhang, 2023). This paper first starts with the application value of computer-aided technology and analyzes the advantages of auxiliary teaching. It then studies the system design of auxiliary teaching platforms and analyzes the system of database construction and network search service. It gives the system framework and teaching process, and the system is applied to art teaching practice and has obtained a certain effect.

Emerging technologies such as AR and VR offer significant training opportunities by enriching real-life information, creating interactive learning environments, and increasing motivation to learn (Parmaxi, 2023). The low cost of production and software innovation has recently increased interest in AR and VR in education, which has resulted in successful applications across various contexts. However, there is a need for a more thorough evaluation, particularly concerning user experience factors, such as usability, satisfaction, quality of experience, and sense of presence. Evaluation models like TAM can help systematize this process. AR and VR are valuable alternatives to traditional learning methods, offering extensive application and research potential (Cabero-Almenara, Llorente-Cejudo, & Martinez-Roig, 2022). Both AR and VR have been well received by experts and students and applied in natural classroom settings, with studies exploring specific scenarios like art exploration in various environments.

2.3.2 THE APPLICATION METHOD OF COMBINING VIRTUAL REALITY AND EDUCATION

2.3.2.1 VIRTUAL ENVIRONMENTS

Virtual environments offer rich, interactive, and engaging educational settings that support experiential learning (Dalgarno, 2004). VR enhances learning through first-person experiences, allowing learners to construct their reality according to individual perceptions (Apostolellis, 2017). This personalized reality enables learners to create models that can be communicated to others but are not fully shared. Meaning can be established from external information or personal interpretation. VR provides immersive environments in which learners build knowledge from direct experiences, offering an “unmediated perceptual illusion” that deepens their understanding and reflection on the learning process (Limniou, Roberts, & Papadopoulos, 2008).

VR technology creates an immersive learning environment distinct from traditional 3D technology. It allows learners to build and apply knowledge, intuitively enhancing their autonomy. Based on prior experience and knowledge of the virtual landscape, learners perform the designed tasks using VR devices. Each learner immerses fully, isolating themselves from the real world and experiencing elements such as wind and nature’s essence. This immersive experience, which is unattainable in the real world, significantly boosts learning enthusiasm, facilitates abstract knowledge comprehension, and provides deep learning support and experiences tailored to their needs (Zhang, 2021).

2.3.2.2 REALISTIC INTERACTIVE DIGITAL CHARACTER

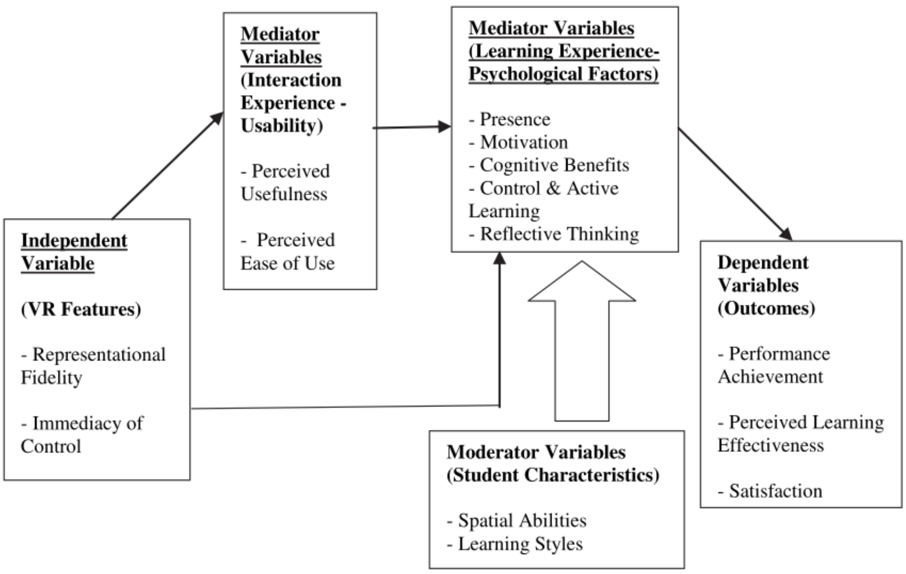
Realistic interactive digital cameras acting as mentors and role-playing actors have been shown to significantly improve learner motivation and retention (Hasler, Tuchman, & Friedman, 2013). The interactive virtual world provides a compelling and effective medium for experiential “learning while doing” training. Both the motivating and teaching aspects of this media can be further enhanced in many applications when these worlds are populated by lifelike virtual people who provide instructions or play roles in interactive stories (Zibrek, Kokkinara, & McDonnell, 2018). However, the use of virtual people to deliver such instructions has thus been limited to a few mostly experimental applications; and few of them are designed to provide instructions over the network (Sims, 2007).

The potential use of virtual people in teaching simulations is almost unlimited, but it is helpful to distinguish between some of the main roles and the functions needed to support these roles. We describe these characters as mentors, teammates (or collaborators), and role-playing actors (Sims, 2007). As mentors, the goal of virtual people is to provide knowledge or ask questions to guide students to discover and construct knowledge.

To serve effectively as mentors, teammates, and actors, virtual humans need a broad range of logical, physical, and visually convincing behaviors, including interactions with students, objects in the environment, and each other. Language is the most crucial interaction, but it must be coordinated with nonverbal communication and actions. Effective virtual humans should be able to perform tasks based on simple, declarative commands, similar to those given to live actors, such as giving an ID to a soldier or expressing concern while pointing in a specific direction, without requiring detailed process descriptions.

Figure 12

Outcomes and Causal Relationships in a Desktop VR-based Learning Environment Conceptual Framework



Note: How does desktop VR enhance learning outcomes?
Source: Lee, E. A. L., Wong, K. W., & Fung, C. C. (2010)

These actions exclude all possible actions of a virtual person. However, for various training tasks they provide the basic components that comprise most of the more complex behaviors. In this system, a key to simplifying the action description of virtual people is that the method of processing objects (e.g., tools, devices, and weapons) includes models of these objects. Even if the task cannot be composed of these basic movements but must be performed, you can prototype the majority of the training scene from these movements and add additional behavior after creating a quick prototype of the rest of the scene (Figure 12).

Figure 12 illustrates the conceptual framework of outcomes in a learning environment based on desktop VR. Under this framework, VR features indirectly influence learning outcomes through the mediating effects of psychological factors of usability and learning experience, such as telepresence, motivation, cognitive gains, control, active learning, and reflective thinking.

2.3.2.3 INTERACTIVE DESIGN IN VIRTUAL REALITY LEARNING

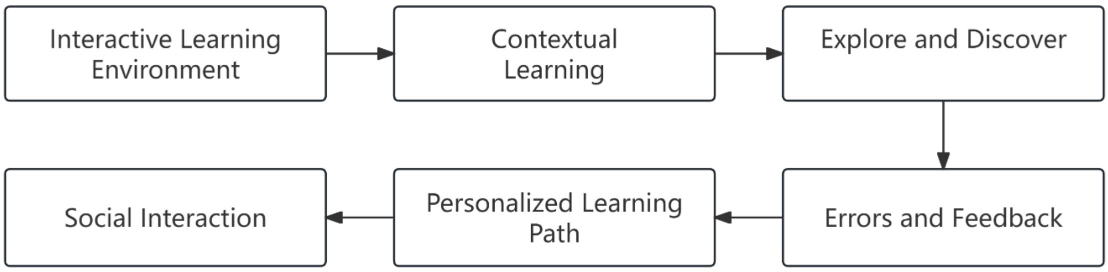
Understanding the dynamics of interactions in online learning environments and learning from the content of these interactions is crucial. Henri identified five critical dimensions for analyzing online discussions: participation rate, types of interactions, social cues, cognitive skills, and metacognitive skills and knowledge (Henri, 1992). These dimensions help us comprehensively understand learners' participation and interaction quality, thereby enhancing the effectiveness of online learning (Burton & Martin, 2010).

2.3.2.4 CONSTRUCTIVIST LEARNING THEORY IN VIRTUAL REALITY

Desktop VR is gaining popularity in modern education due to its ability to provide real-time visualization and interactions in a virtual world that closely resembles the real world. Desktop VR supports constructivist learning by offering a highly interactive environment in which active participants control their own learning pace and take responsibility for their learning. The various technical capabilities of VR technology align with constructivist educational design principles that emphasize active engagement. This allows learners to control their content, order, and knowledge acquisition strategies. Authentic, situational, and discovery activities foster diverse ways of thinking, while interesting, attractive, and engaging problem presentations provide intrinsic motivation (Lee, Wong, & Fung, 2010).

Constructivist learning theory posits that learners construct their understanding and knowledge through experiences and reflection (Hein, 1991). It emphasizes active participation, learner control over the pace and content of learning, social interaction for collaborative learning, and connection of learning experiences to real-life contexts (Bada & Olusegun, 2015). Reflection on these experiences helps integrate new knowledge with existing understanding, supporting a student-centered approach in which learners explore, ask questions, and develop their insights (Figure 13).

Figure 13
Constructivism Learning Theory Conceptual Framework



Source: Drawn by the author based on the Constructivism Learning Theory Concept

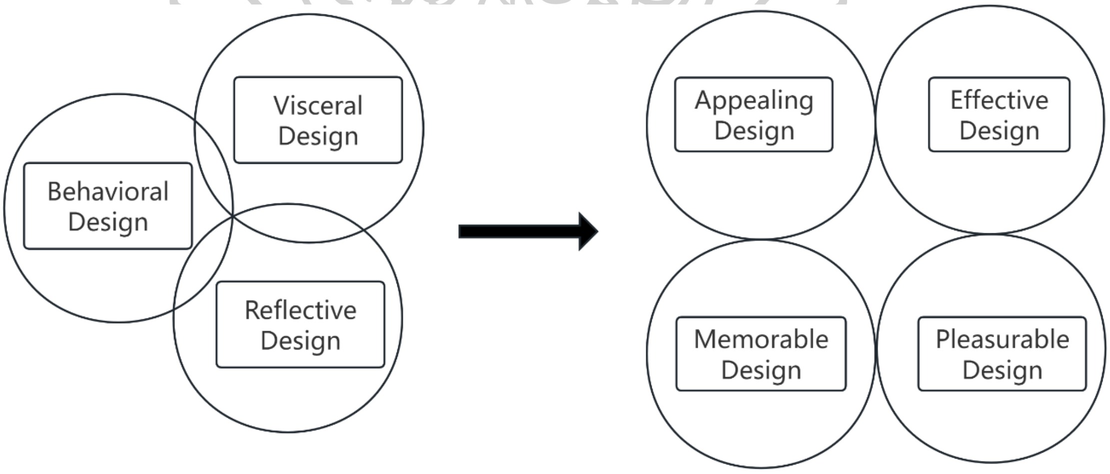
2.3.2.5 EMOTIONAL DESIGN THEORY IN VIRTUAL REALITY

Emotional Design Theory in VR focuses on crafting VR experiences that evoke specific emotional responses to enhance user engagement and immersion (Marcolin et al., 2021). It integrates multisensory stimuli, such as visuals, sounds, and haptic feedback, to create compelling environments that resonate emotionally with users (Marcolin et al., 2021). By designing VR elements that provoke emotions, developers can make experiences more impactful and memorable, thereby enhancing learning, entertainment, and user satisfaction.

Critical components of this theory include multisensory stimulation, user-centered design, engagement and immersion, and contextual relevance. These elements work together to create environments where users feel fully engaged and present, which enhances the emotional impact of VR experiences. Emotional design in VR is applied in various fields, including education, therapy, and entertainment, to create more immersive and emotionally engaging experiences.

The benefits of Emotional Design Theory in VR include enhanced user experience, improved learning outcomes, and increased engagement. By focusing on emotional engagement, VR experiences can become more memorable and satisfying, leading to higher user interaction and retention (Yusa, Ardhana, Putra, & Pujaastawa, 2023). This approach significantly improves engagement, learning, and satisfaction across different applications (Figure 14).

Figure 14
The Emotional Design Theory Conceptual Framework



Source: Drawn by the author based on the Emotional Design Theory Concept

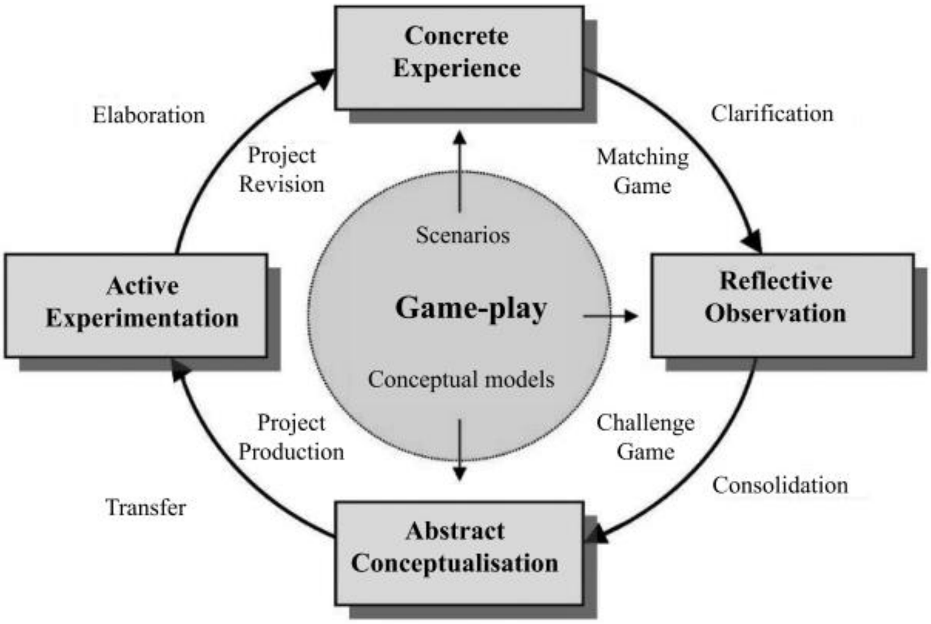
2.3.2.6 GAMIFICATION IN VIRTUAL REALITY

In recent years, game-based learning has been recognized as an effective method to help students construct knowledge through gameplay (Huang & Soman, 2013). The proposed approach maintains high motivation for learning and enables the application of acquired knowledge to real-life problem-solving scenarios. By engaging in games that combine problem-solving and challenges, game-based learning allows learners to build knowledge through ambiguity, trial and error, and absorb new information (Caponetto, Earp, & Ott, 2014).

Game-based learning can provide a rich learning environment that helps learners build higher-level knowledge and skills through ambiguous and challenging trial-and-error opportunities (Robson, Plangger, Kietzmann, McCarthy, & Pitt, 2015). During gameplay, learners engage in higher-order cognitive activities using trial and error to enhance their attention, selection, activation, and retention processes. This dynamic interaction allows for deeper understanding and mastery of new concepts and fosters cognitive and practical skills in an engaging and motivating manner (Wang & Chen, 2010).

The experiential game framework combines game experiences with the experiential learning cycle (Figure 15). In challenging games, learners challenge themselves by completing tasks within set time limits, performance levels, and cumulative scores and identifying correct concepts and examples to improve performance and achieve higher scores. The trial-and-error process in challenging games also allowed learners to reflect on and reuse their strategies, refining their established knowledge and motivating them to try again. Acquiring cognitive skills is a “learning by doing” process, transforming declarative knowledge into procedural knowledge.

Figure 15
The Experiential Gaming Framework Incorporates Gameplay with the Experiential Learning Cycle



Note: The effects of game strategy and preference-matching on flow experience and programming performance in game-based learning.
Source: Wang, L. C., & Chen, M. P. (2010)

2.3.3 APPLICATION CASES AND EFFECT EVALUATION OF VIRTUAL REALITY IN THE FIELD OF EDUCATIONAL EXPERIENCE

VR is achieved through a combination of various technologies that visualize virtual environments and allow interaction with them (Christou, 2010). This section analyzes several case studies of VR applications in different educational fields. The analysis will be conducted from three perspectives: teaching objectives, user experience, and outcome evaluation.

2.3.3.1 THE APPLICATION OF IMMERSIVE VIRTUAL REALITY IN THE DISTANCE TEACHING OF ARCHITECTURAL HISTORY

This study explored the application of VR in education, particularly in teaching architectural history within a distance learning framework (Chan, Bogdanovic, &

Kalivarapu, 2022). The analysis focused on teaching objectives, user experience, and outcome evaluation, aiming to assess VR’s effectiveness in enhancing students’ understanding and appreciation of architectural details and historical contexts. By providing a VR experience of the Pantheon in Rome, the study sought to deepen students’ engagement with architectural history through high-resolution visuals and immersive audio. Feedback from students indicated that VR provided a high-quality learning experience, enabling direct interaction with intricate historical elements. This interaction significantly improved their understanding and sustained interest. The immersive nature of VR was particularly impactful, allowing students to fully engage with the virtual environment. While the teachers noted some technical challenges, overall, they found VR to be an effective tool in supporting educational goals. The outcome evaluation used questionnaires, control studies, and interviews to measure student interest, understanding, and memory retention. The key metrics included changes in academic performance, levels of engagement, and shifts in learning attitudes. The results demonstrated that the students had a better grasp of architectural details and maintained high interest and positive attitudes toward VR-based teaching. Despite challenges such as high costs and technical complexity, the study suggested that VR’s effectiveness could be further enhanced through more interactive content, improved technical support, and comprehensive teacher training.

2.3.3.2 VIRTUAL REALITY TECHNOLOGY IN ART DESIGN TEACHING

When studying the application of VR in art design teaching, the analysis focused on teaching objectives, user experiences, and outcome evaluation. The main objective is to assess VR’s effectiveness in enhancing traditional art design teaching methods, deepening students’ emotional experiences, and improving their learning abilities (Du, 2021). This study provides a more immersive and interactive learning experience by integrating VR into art design courses, enhancing students' understanding and appreciation of design concepts.

The study revealed that VR significantly enhances the learning experience in art design education by enabling direct interaction with detailed design elements, which greatly improves students' understanding and interest. The immersive nature of VR was particularly impactful, allowing students to fully engage with the virtual environment. Although some technical challenges, such as hardware compatibility and software stability, were noted, teachers generally found VR to be an effective tool for enriching the teaching process. The evaluation of VR's impact on learning outcomes included questionnaires, control studies, and interviews, focusing on student interest, understanding, and memory retention. Results indicated that students using VR demonstrated better comprehension and retention of design details, with increased engagement and positive attitudes toward VR-based learning. Despite challenges like high costs and technical complexity, the study suggests that VR's effectiveness can be further enhanced through more interactive content, better technical support, and additional teacher training. Overall, the study highlights VR's potential to revolutionize art design education by enhancing understanding, interactivity, and student engagement.

2.3.3.3 VIRTUAL REALITY IN EDUCATION AND WORKFORCE TRAINING

When studying the application of VR in education and workforce training, the analysis focused on teaching objectives, user experiences, and outcome evaluation. The primary objective is to assess VR's effectiveness in improving training methods, particularly in industrial workspaces and tool safety training. This study aims to provide a realistic and interactive learning experience by integrating VR into training programs, thereby enhancing trainees' understanding and skill acquisition (Carruth, 2017).

Student feedback indicates a high-quality learning experience where the VR allowed direct interaction with the training elements, which significantly enhanced understanding and interest. Increased immersion and engagement were notable because VR enabled trainees to fully immerse themselves in a virtual environment. The instructors acknowledged some technical challenges, such as hardware compatibility and software stability; however, overall, VR effectively supported and enriched the training process.

Outcome evaluation used questionnaires, control studies, and interviews to assess trainees' interest, understanding, and skill retention. Metrics included changes in performance, engagement, and learning attitudes. Results showed that trainees using VR better understood and retained training details, with high interest and positive attitudes toward VR training. Despite challenges like high costs and technical complexity, the study suggests that VR's effectiveness can be further enhanced with more interactive content, improved technical support, and additional instructor training. This study demonstrates VR's significant potential to transform education and workforce training, enhancing understanding, interactivity, and trainee engagement and introducing new possibilities to modern training programs.

2.3.3.4 TEACHING INTERNATIONAL BUSINESS USING VIRTUAL REALITY

VR in education has long been debated, primarily concerning whether VR is a conceptual idea or a functional technology. For educators, viewing VR as a tool to achieve educational goals rather than an end is crucial. Conceptually, designers focus on learning processes such as cognition, social interaction, and emotional response, while technology emphasizes the construction of software and mechanical systems (Hernandez-Pozas & Carreon-Flores, 2019). Wu et al. underscored the importance of focusing on VR's conceptual aspects in education. Multi-User Virtual Environments (MUVE) allow multiple users to simultaneously engage in a virtual space. Students can represent themselves using avatars, interact with peers, and experience realistic environments. An example is Tecologico de Monterrey's immersive learning program, where students apply their knowledge and develop skills in a VR environment.

Practical applications of VR extend beyond education to the business sector. Companies like Walmart, KFC, Boeing, and NASA use VR for various training programs, from sales and employee training to pilot and astronaut training. VR is also utilized in recruitment, shopping experiences, and consumer behavior research. VR offers high levels of interaction, engagement, and learning effectiveness; however, VR also presents challenges, such as the need for high-speed networks and potential physical discomforts like vertigo and simulator sickness. Additionally, the engaging nature of VR may distract students from their learning objectives. VR is a powerful educational tool; however, its practical use is essential to achieve educational goals.

2.3.3.5 CASE ANALYSIS SUMMARY

The application of VR in education and training has been extensively studied across various fields, highlighting its potential to revolutionize traditional methods. In architectural history, VR enhances students' understanding and appreciation of details and historical contexts through immersive experiences despite technical challenges. In art design teaching, VR provides an interactive learning environment that deepens emotional engagement and improves the comprehension and retention of design concepts while addressing similar technical hurdles. For workforce training, particularly in industrial and tool safety contexts, VR offers realistic and interactive simulations that improve skill acquisition and retention. However, it also faces challenges such as high costs and technical complexity. Additionally, using VR in teaching international business emphasizes the importance of conceptual learning processes, demonstrating its utility in both educational and business sectors for training programs, recruitment, and consumer research. Overall, while VR brings significant benefits in terms of interaction, engagement, and learning effectiveness, it also presents challenges that require careful management to achieve educational goals effectively.

2.4 PROSPECT OF THE APPLICATION OF VIRTUAL REALITY IN SNOWBOARDING TEACHING

2.4.1 APPLICATION OF VIRTUAL REALITY IN SPORTS EXPERIENCES

VR has been increasingly applied in sports education and training, offering immersive environments that enhance decision-making skills, such as prediction and movement analysis. A systematic literature review titled “The Application of Virtual Reality Technology in Sports Education and Training” identified a growing trend in the use of VR, particularly through the combination of head-mounted displays (HMDs) and motion capture systems (Putranto, Heriyanto, Achmad, & Kurniawan, 2023). This method has proven effective in improving athlete performance and helping coaches design better training strategies.

The application of VR in sports involves creating computer-simulated environments where individuals can interact with virtual sports scenarios with the aim of replicating a sense of reality. This interactivity is a crucial element that differentiates VR from static displays and non-animated content (Rynarzewska, 2018). Unlike general fitness and sports games, VR in sports focuses on motor skills, hand-eye coordination, and competitive elements. Despite its potential, VR in sports faces challenges related to technical limitations and the need for clear definitions. VR typically relies on 3D and 360-degree environments, requiring users to wear VR headsets or be in immersive rooms that mimic natural surroundings with the goal of making participants feel as if they were in a real environment.

VR training is as practical as video training, and VR skills can be effectively transferred to natural environments (Waller, Hunt, & Knapp, 1998). VR applications have been widely used, and head-mounted displays (HMD) are favored for their portability and practicality. HMDs have been applied in health care and education, especially in sports, where they enhance immersion by ensuring natural movements. However, only a few studies have compared the quality of visual perception cues in VR with those in natural conditions or discussed how to conceptualize VR training to effectively acquire complex sensorimotor skills. To realize more realistic VR training, different measurement systems have been incorporated, such as eye-tracking, electroencephalography, and motion capture systems. These systems help translate physical movements into virtual sports performances (Gallagher et al., 2013).

Visual feedback is considered adequate for improving motor skills in sports training because athletes can detect and correct errors. Visual feedback can either show expert performance videos or provide continuous visual feedback of the athlete’s movements. Visual feedback has not become a significant tool due to limitations in presentation types (Grassini, Laumann, & Rasmussen Skogstad, 2020). VR has great potential in this regard because it can provide realistic training scenarios through a first-person perspective.

The construction of training interventions follows specific guidelines to improve the understanding of the relationship between motor techniques and functions through motion analysis. Target values are generated to optimize training by presenting virtual avatars or athletes. Slow movement reduction helps reinforce the internal representation of optimal techniques. Integrating external feedback from trainers or avatars can provide participants with the actual value of their movements, which is crucial, especially when learning a new sport (Pastel et al., 2023). While slowing down the movements initially is advantageous, real-time presentation of the movements is also essential. Therefore, starting with slow movements and gradually increasing the speed throughout the training stages is an effective training method.

Understanding how perceptual information guides actions toward expert performance is crucial when training or collaborating with athletes. While experts acknowledge the relationship between perception and action, scholars debate the nature of this relationship. Indirect approaches suggest that skilled performers use internal representations to search the visual field, predict events, and verify information sources. However, this method must explain consistent performance under varying conditions and time constraints (Craig, 2013b). An alternative is the ecological approach, viewing perception and action as directly related. According to this method, perception generates action, and action generates perception in a continuous loop. This approach promotes information exchange between athletes and their environment without requiring internal representations or memory stores. Information changes as athletes move, guiding their actions. This perspective, derived from Gibson's ecological approach to visual perception, highlights the role of environmental attributes in guiding actions.

Bian et al. (2016) developed a framework for physiological indicators of flow in VR games by identifying flow as a state of complete immersion in an activity that optimizes user experience (UX) (Bian et al., 2016). Flow experiences significantly influence perceived ease of use, thus impacting technology acceptance and usage. Maintaining flow states in VR design helps optimize UX and improve game design. Studies have demonstrated that flow experiences are crucial to performance and effort expectations and enhance technology-related user experiences (Craig, 2013a).

Reinhard E. Kunz and colleagues focused on sports VR from the consumer's perspective, focusing on three key factors that positively impact technology acceptance: performance expectancy, social influence, and hedonic motivation (Kunz & Santomier, 2020). Several factors influence user acceptance of VR technology. Performance expectancy refers to users' anticipation of obtaining high-quality sports content and interactive experiences using VR technology. When VR provides clear, realistic visuals and smooth interactions, user performance expectations are satisfied, which increases their willingness to use the technology. Social influence, which encompasses opinions and attitudes from friends and family, social media discussions, and public endorsements, also plays a significant role.

2.4.2 CASE ANALYSIS AND EFFECT EVALUATION OF VIRTUAL REALITY SPORTS

The application of VR technology in sports is increasingly widespread and capable of simulating complex training scenarios and enhancing athletes' decision-making abilities (Faure, Limballe, Bideau, & Kulpa, 2020). However, current research still needs to improve the technical limitations and design issues, including the latency, limited field of view, and lack of feedback. Despite VR's significant potential in training and maintaining perceptual abilities, further research is required to optimize its effectiveness and ensure that virtual skills can be transferred to real-life sports. Future VR technology should be an auxiliary tool that focuses on specific training capabilities and provides immersive and compelling scenario simulations. This section details some of the case studies for analysis and discussion.

2.4.2.1 CASE ANALYSIS OF SNOW SPORT VIRTUAL REALITY GAMES

1) VR Game: Carve Snowboarding

With the rapid development of technology, VR games have gradually become a major trend in the game industry. In this case analysis, we perform a detailed analysis of a VR game called Carve Snowboarding. This analysis will include the background introduction, target audience, core gameplay, in-game interactive design, and game market performance.

Carve Snowboarding is a skiing game developed by Chuhai Labs for Oculus Quest 2 VR devices. Released in May 2021, the game gives players an immersive snow–mountain skiing experience. The core gameplay of Carve Snowboarding simulates snow mountain skiing. Players can choose different ski trails and ski equipment and operate through VR equipment and motion-sensing controllers to experience realistic skiing movements.

2) VR Game: Skiing

The Skiing VR is a VR ski game developed by XYZ Studios for all kinds of VR devices such as Oculus Rift and HTC Vive. The game aims to provide players with an immersive skiing experience, allowing them to feel the excitement of ice and snow sports right away from home.

3) Fancy Skiing VR Game Analysis

With the continuous progress of VR technology, the video game market is rising rapidly. In this case analysis, we perform a detailed analysis of a VR game called “Fancy Skiing VR.” The analysis includes the game background introduction, target audience, core gameplay, in-game interactive design, and game market performance.

The Fancy Skiing VR is a VR ski game developed by Odders Lab that was designed for various VR devices, such as Oculus Rift and HTC Vive. The goal of the game is to provide players with a real skiing experience while adding various creative elements to make the game more entertaining.

4）SNOW Game

As the video game industry continues to grow, an increasing number of independent developers and teams are attempting to turn ideas into reality. In this case analysis, we conduct a detailed analysis of a game called “SNOW.” This is an open-world ski game developed by Poppermost Productions and released via Steam Early Access. The analysis includes the game background introduction, target audience, core gameplay, in-game interactive design, and game market performance.

SNOW is an open-world ski game where players can explore and glide freely in a huge snowy mountain environment. The game was developed by Poppermost Productions, an independent development team, and it was released via Steam Early Access. This allows developers to collect comments and suggestions during development to refine and optimize the game.

5) Cross-country Skiing VR Game

With the continuous development of VR technology, an increasing number of VR games have emerged. In this case analysis, we perform a detailed analysis of a cross-country skiing VR game. It is a ski simulation game released by Steam. The analysis includes the game background introduction, target audience, core gameplay, in-game interactive design, and game market performance.

Figure 16
The equipment of the Game: Enjoy Skiing

Source: Screenshot by the author

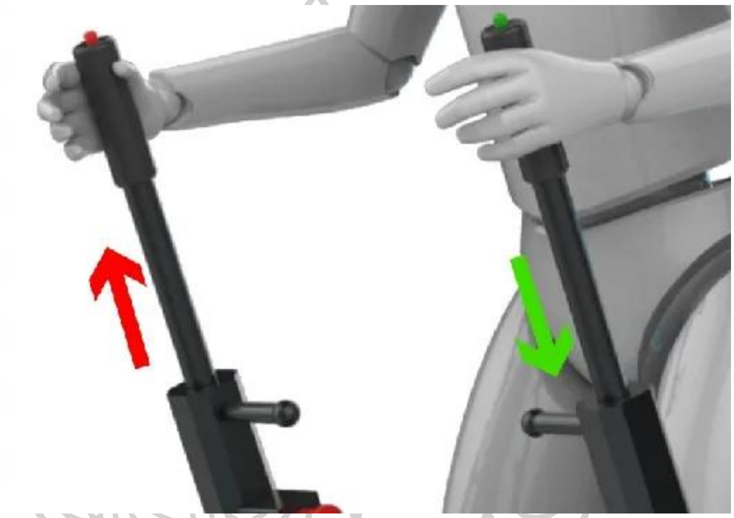
Cross-Country Skiing VR is a ski simulation game designed for VR devices. The game is designed to provide players with realistic cross-country skiing experiences. Released through Steam, the game supports various mainstream VR devices, such as the Oculus Rift, HTC Vive, and others.

6) Enjoy Skiing

“Enjoy Skiing” is a ski simulation game designed specifically for VR devices. The game is 9designed to provide a real skiing experience by simulating various movements and scenes of skiing and providing players with an immersive gaming experience (Figure 16).

The core gameplay of “Enjoy Skiing” is to simulate skiing. The players operated through VR devices and lampads to experience real ski movements (Figure 17). The main gameplay includes

Figure 17
The Armrest Adjustable of the Game: Enjoy Skiing



Note: Players, according to height, adjust appropriate height-free play barrier-free.
Source: screenshot by the author

In order to enhance the immersion and enjoyment of the game, “Enjoy Skiing” has added many interactive elements to the game, including real skiing physical simulation, interactive sound effects, environmental interaction, and so on. These designs allow players to feel the fun of skiing more deeply (Figure 18).

“Enjoy Skiing” uses the large design of a white snow mountain, dynamic light snow ornaments, blue light mapping transparent acrylic, and other design elements to create a cold and refreshing skiing atmosphere, greatly increasing the player’s desire to experience.

Figure 18

The Head-on Wind Range Can Be Adjusted Manually of the Game: Enjoy Skiing

Note: According to the player's height within the adjustable range, adjust the appropriate wind height to achieve a natural ski-blowing feeling.

Source: screenshot by the author

SUMMARY

The researchers tried and investigated these VR ski games. Some commonalities and differences were eventually summarized.

Commonalities Across the VR Game Case Studies:

a. Immersive Experience:

All VR games analyzed—First Person Tennis, Eleven: Table Tennis VR, Badminton VR, and Pickup Basketball VR—emphasize providing an immersive experience. Each game leverages VR to simulate real-life sports scenarios, allowing players to engage deeply in the sport as if they were physically present in a real environment.

b. Realistic Physical Simulation:

These games use sophisticated physics engines to simulate the real-world dynamics of each sport. For example, they replicate the behavior of tennis balls, table tennis balls, shuttlecocks, and basketballs, ensuring that the in-game movements closely mimic real-life sports physics.

c. Core Gameplay Modes:

Each game includes single-player modes (often with AI opponents), multiplayer online modes, and training modes. These core gameplay elements are designed to accommodate casual players and those seeking to improve their skills.

d. Interactive Design:

The games incorporate interactive elements like real-time feedback, sound effects that react to in-game actions, and social features such as leaderboards and online multiplayer interactions. These features enhance the immersion and engagement of the game.

e. Target Audience:

All games target similar groups: VR enthusiasts, sports fans, and players who enjoy sports games or seek new, engaging experiences. This demographic overlap is due to the nature of VR sports games, which appeal to those interested in both gaming and physical sports.

f. Market Performance:

Each game has achieved positive market reception, as evidenced by good sales, high ratings, and substantial attention on social media platforms. This indicates the successful adoption of VR sports games by target audiences.

Differences Among the VR Game Case Studies:

a. Sports Focus:

Each game is based on a different sport—tennis, table tennis, badminton, and basketball. This distinction shapes the unique gameplay mechanics and physical simulations required to accurately represent each sport in a VR environment.

b. Physical Requirements:

Physical requirements and interactions differ according to sport. For example, the movement patterns and controller inputs for a basketball game like Pickup Basketball VR differ significantly from those in a game like Eleven: Table Tennis VR.

Basketball may require more extensive body movements, whereas table tennis focuses on precise wrist and arm movements.

c. Customization and Personalization:

The level of customization varies among games. For instance, First Person Tennis allows for character and equipment customization, enhancing the personalization of gaming experiences, while others offer less in-depth customization options.

d. Complexity of Simulation:

The complexity of physical simulations can vary depending on the sport. Tennis and badminton may involve more intricate simulations of ball trajectory and racket interactions than table tennis or basketball, where the scale of the environment and the speed of interactions differ.

e. Market Niche:

Although all games target VR and sports enthusiasts, the specific fan base differs. For example, Pickup Basketball VR appeals more to fans of street basketball culture, whereas Badminton VR attracts those with a specific interest in badminton. These niche markets shape the game's design and marketing strategies.

2.4.2.2 CASE ANALYSIS OF OTHER SPORTS VIRTUAL REALITY GAMES

1) Eleven: Table Tennis VR Game

VR games have become an increasingly popular form of entertainment. Eleven: Table Tennis VR is a table tennis-themed VR game that helps players improve their table tennis skills. This case analysis explores the game's background, target audience, core gameplay, interactive design, and market performance.

Eleven: The Table Tennis VR game simulates real table tennis, providing players with an immersive table tennis experience. The game supports various mainstream VR devices, such as Oculus Rift, HTC Vive, and other devices. Through the combination of VR technology and table tennis, the game provides players with a brand-new experience of table tennis.

2) Badminton VR Game

With the increasing advancement of VR technology, VR games have become an increasingly popular form of entertainment. The Badminton VR is a VR game that simulates badminton and helps players improve their badminton skills in a virtual environment. This case analysis explores the game’s background, target audience, core gameplay, interactive design, and market performance.

The Badminton VR is a badminton-themed VR game that provides players with an immersive badminton experience. The game supports various mainstream VR devices, such as Oculus Rift, HTC Vive, and other devices. Through the combination of VR technology and badminton, the game provides players with a new badminton experience.

Through a case analysis of Badminton VR, we can see its advantages in terms of game design, interactive elements, and market performance. With its real badminton experience and immersive virtual reality setting, the game has attracted many gamers who enjoy VR games. In the future, Badminton VR is expected to continue to occupy a prominent position in the gaming market, bringing an exciting and interesting badminton experience to more players.

3) Pickup Basketball VR Game

With the continuous development of VR technology, an increasing number of VR games are being introduced to the market. The Pickup Basketball VR is a VR game that simulates street basketball, providing players with a whole new basketball experience through virtual reality technology. This case analysis will discuss the game’s background, target audience, core gameplay, interactive design, and market performance.

The Pickup Basketball VR is a street basketball-themed VR game that provides players with an immersive basketball experience. The game supports various mainstream VR devices, such as Oculus Rift, HTC Vive, and other devices. The developers of the game hope to bring players a new basketball experience by combining VR technology with street basketball sports.

SUMMARY

The researchers tried and investigated these VR ski games. Some commonalities and differences were eventually summarized.

Commonalities Across the VR Game Case Studies:

a. Target Audience:

All three games—Eleven: Table Tennis VR, Badminton VR, and Pickup Basketball—are aimed at similar target groups: VR game enthusiasts, sports fans (specific to the sport), and players who are looking for engaging, fresh, and exciting experiences. These target groups highlight the intersection of sports and VR technology.

b. Core Gameplay:

Each game simulates real-life sports using VR technology. The core gameplay involves using VR devices and motion controllers to mimic the physical movements of table tennis, badminton, and basketball. These simulations are designed to replicate the experience of playing an actual sport as closely as possible, making the games suitable for both casual players and those aiming to improve their skills.

c. Interactive Design:

The games emphasize interactive design elements to enhance immersion. Physical simulation is key, with each game striving to accurately simulate the dynamics of the sport, whether it is the movement of a ball or shuttlecock. Additionally, interactive sounds are adjusted based on gameplay actions, which deepens the sense of realism. Real-time feedback is a common feature that provides players with immediate performance metrics (e.g., shot accuracy, scores) to help them understand and improve their skills. Social interaction is facilitated through multiplayer modes, leaderboards, and the ability to share results, thus encouraging competition and community building.

d. Market Performance:

All three games were well received in the market, with positive user reviews, strong sales, and significant social media attention. This success underscores the growing popularity of VR sports games and their appeal to a broad audience.

Differences Among the VR Game Case Studies:

a. Sport Focus:

The primary difference lies in the specific sport each game simulates: table tennis for Eleven: Table Tennis VR, badminton for Badminton VR, and street basketball for Pickup Basketball VR. This distinction influences every aspect of the game, from the physical simulation to the types of movements and skills emphasized during gameplay.

b. Complexity and Physical Requirements:

The complexity of physical simulations varies depending on the sport. For example, table tennis may require precise wrist and arm movements, while basketball involves more extensive body movements, such as dribbling and shooting. These differences affect the overall gameplay experience and physical requirements of the players.

c. Customization and Personalization:

The level of customization can differ between games. For instance, some games allow for a more detailed personalization of avatars, equipment, and environments, while others may focus more on the core gameplay and interactions with the sport.

d. Cultural and Market Niches:

Pickup Basketball VR may appeal more to fans of street basketball culture, whereas Eleven: Table Tennis and Badminton VR attract enthusiasts of their respective sports. These cultural connections influence how games are marketed and the specific features that are highlighted to attract niche audiences.

e. Physical Interaction Scope:

Physical interactions vary according to the sport's nature. Basketball involves more full-body movement and coordination than table tennis and badminton. This impacts how players interact with the VR environment and the types of spaces required for gameplay.

2.4.2.3 SUMMARY OF THE CASE ANALYSIS

These games offer various gameplay modes, including single-player, multiplayer, and training modes, all designed to enhance player engagement and skill development. While they share these core features, differences arise in the simulated specific sport, the level of customization, and the cultural appeal of each game, which cater to distinct market niches and player preferences. These factors highlight the importance of common design principles and tailored elements in creating successful VR sports games.

2.4.3 POTENTIAL ADVANTAGES OF VIRTUAL REALITY TECHNOLOGY IN SNOWBOARDING TEACHING

VR technology holds significant potential for sports consumption, but its success hinges on fan acceptance. Sports teams looking to invest in VR technology need to understand whether fans are willing to accept VR. If fans are uninterested, organizations may allocate resources elsewhere. Conversely, excited fans might prefer institutions that offer VR experiences. Perceived prestige and uniqueness can influence fan recognition, loyalty, and donations, benefiting organizations that compete for fans' discretionary incomes. VR also aids advertisers in enhancing customer relationship management and offers new ways to deliver information, deepening fan-organization connections (Rynarzewska, 2018). VR offers sports fans an immersive experience by placing them in nearly natural environments, enhancing their engagement with games they cannot attend in person. This digital medium facilitates easy access to information, games, and exclusive content, enriching the overall fan experience and fostering stronger attachments to their favorite teams. This increased attachment can lead to positive word-of-mouth, higher spending, and more frequent game attendance, which in turn boosts revenue for teams and leagues. As sports fans are highly loyal, the competition for their spending is intense. The sports industry could see significant changes with the adoption of VR, which research suggests is more likely when fans have an existing interest in sports and positive attitudes toward VR. Thus, managers should focus on promoting VR's ease of use and value proposition to enhance positive attitudes, ultimately benefiting consumers and sports organizations.

VR is an appropriate tool for learning specific sports techniques, especially for beginners. Research has also found high levels of interest and motivation in training methods that have yet to be experienced. Future work should clarify these benefits to maximize learning progress during the VR learning process. The results indicate that learning high-skill movements is not more effective than merely being in an immersive virtual environment. To reveal all these advantages, VR may bring additional features in the future, such as real-time feedback on performance, interaction with virtual avatars, or other sources of feedback like auditory cues (Pastel et al., 2023). The results indicate that visualizing the entire body is optional. Individual limbs can be visualized using simple sensors without complex technical components. Of course, other tracking methods, such as Vive Tracker, can be used to visualize the hands or feet, which should be sufficient to provide feedback on one's position in the virtual scene and display additional feedback on limb positions. Since this study mainly focused on the visual perception of critical elements in the learning process, different learning types should be considered in future research.

2.5 RELATED RESEARCH

In a study by Radianti, Majchrzak, Fromm, and Wohlgenannt (2020), the research explored the applications and effectiveness of immersive VR in higher education (Radianti, Majchrzak, Fromm, & Wohlgenannt, 2020). This research addresses the growing interest in VR technology, particularly the use of head-mounted displays (HMDs) for enhancing educational experiences in university settings. This study identifies the key design elements, learning content, and theories used in VR applications and systematically maps the existing literature to identify trends, gaps, and opportunities in the field. Using a systematic mapping approach, the researchers reviewed a range of articles from multiple digital libraries with the aim of understanding the integration of immersive VR into higher education settings. This section examines the design elements of VR systems, the applied learning theories, and the methods used to evaluate educational outcomes. The research reveals that despite the increasing use of VR, there is a significant gap in the application of learning theories and a tendency to focus more on usability than on the educational impact of such technologies. The results suggest that while immersive VR holds great promise for enhancing education, its full potential has yet to be realized due to the lack of theory-driven design and comprehensive outcome evaluations. The study concludes by recommending future research directions that focus on integrating robust educational theories with VR design and systematically assessing the impact on learning outcomes.

In the research conducted by Putranto et al. (2023), the study systematically reviews the implementation of VR technology in sports education and training (Putranto et al., 2023). This study aims to assess the current state of VR applications in this field, identify the most effective methods for using VR in sports training, and provide insights into the benefits and challenges associated with VR use. The researchers performed a systematic literature review and analyzed 995 articles from various scientific databases, ultimately selecting 30 studies that met the inclusion criteria. This study identifies that VR is increasingly being applied in sports education, with HMDs and motion capture systems being the most common technologies. The review reveals that while VR has demonstrated significant potential in improving sports skills, enhancing training efficiency, and providing innovative educational experiences, challenges remain. These include the limitations of HMDs on physical movement and the need to improve the accuracy of motion capture systems. The findings suggest that VR technology plays a crucial role in enhancing sports training by improving athletes' performances and supporting coaches in crafting more effective strategies. However, further research is required to address the current limitations and explore new approaches that can enhance the effectiveness and usability of VR in sports education and training. The findings of this review provide a foundation for future research and development in the field, aiming to optimize the integration of VR technology into sports education.

In the research presented in the "Special Issue: Augmented and VR in Education: Immersive Learning Research," the focus is on exploring the potentialities, affordances, and challenges of immersive learning environments in educational contexts (Beck, 2019). This study emphasizes the optimal use of virtual and augmented reality technologies to enhance educational experiences by increasing their engagement, motivation, and effectiveness. This research addresses existing gaps in the literature, particularly focusing on the application of immersive technologies across various academic disciplines, the use of various pedagogical approaches within such environments, and the technical capabilities that these technologies offer. The study employed a systematic review of the existing literature and analyzed various case studies and experimental applications of immersive learning technologies. This research covers multiple educational contexts, from primary education to higher education, and examines how these technologies can be used to improve learning outcomes, motivation, and student engagement. The findings suggest that while immersive technologies such as augmented and VR technologies hold significant promise for enhancing learning, their effectiveness varies across different subjects and educational levels. Moreover, the study identified the need for further research to explore how these technologies can be best integrated into curricula and how they can be adapted to meet the needs of diverse learner populations.

In the research by Hu-Au and Joey J. Lee, the study explores the role of VR in education within the context of the “Experience Age,” where traditional teaching methods are increasingly ineffective in engaging students (Hu-Au & Lee, 2017). This research focuses on how VR can address significant challenges in modern education, such as student disengagement, the difficulty of providing authentic learning contexts, and the need to teach 21st-century skills like creativity, empathy, and abstract reasoning. This study provides a comprehensive overview of VR technology’s evolution, the study emphasizes its potential to craft highly immersive and interactive learning environments. The researchers identified several key opportunities for VR, including increased student engagement through immersive experiences, the facilitation of constructivist learning, and the ability to provide authentic, context-rich educational experiences. VR is also effective in developing empathy and creativity among students by allowing them to experience different perspectives and visualize complex concepts. The study concludes that while VR holds great promise as an educational tool, its implementation should be guided by sound pedagogical principles, particularly those grounded in constructivist learning theories. The researchers emphasize the importance of designing VR experiences that go beyond replicating traditional classroom activities and instead leverage the unique affordances of VR to create more engaging, authentic, and effective learning environments. This research underscores the potential of VR to transform education by meeting the needs of students in the Experience Age.

In a study conducted by Takayuki Nozawa, Erwin Wu, and Hideki Koike, the research introduces the “VR Ski Coach,” an innovative indoor ski training system designed to visualize and compare a user’s skiing technique with that of a professional skier using VR, was introduced (Hu-Au & Lee, 2017). This study addresses the challenges associated with traditional ski training, such as environmental constraints and the difficulties beginners face in mimicking expert movements due to the dynamic nature of skiing. This system integrates a VR head-mounted display with an indoor ski simulator, which is equipped with motion trackers to record ski movements. The system includes three key features: a coach replay function that allows users to follow the motions of a professional skier in real time, a time control function that enables users to adjust the speed of the replay for better analysis, and a foot angle visualization tool that graphically displays the differences between the user's movements and the expert's. Pilot tests with beginner skiers demonstrated that the system effectively helped users understand expert movements, providing positive feedback on its potential as a training tool. However, the study also highlights areas for improvement, such as the need for more comprehensive evaluations, the inclusion of additional motion tracking for better feedback, and solutions to reduce VR-induced motion sickness.

In their research titled "Virtual Ski Training System that Allows Beginners to Acquire Ski Skills Based on Physical and Visual Feedback," Okada and colleagues explored the development and effectiveness of a VR ski training system designed to help beginners acquire ski skills (Okada et al., 2023). This research addresses the challenges that beginners face in traditional ski training, such as environmental constraints and the difficulty of understanding and replicating expert movements. The VR system combines physical feedback from an indoor ski simulator with visual feedback displayed via a head-mounted display. The system allows users to ski in a virtual environment while receiving real-time feedback on their performance compared to a recorded expert skier. This dual-feedback approach enhances skill acquisition by allowing users to visualize and experience correct techniques. A series of experiments with beginner skiers was conducted to evaluate the effectiveness of the proposed VR training system. The results indicated that the combination of physical and visual feedback significantly improved the ability of the participants to learn and replicate proper skiing techniques. The system was particularly effective at helping beginners understand and correct their postures and movements, which are critical for safe and effective skiing.

In the research conducted by Radianti, Majchrzak, Fromm, and Wohlgenannt titled "A Systematic Review of Immersive Virtual Reality Applications for Higher Education: Design Elements, Lessons Learned, and Research Agenda," the study systematically reviews the use of immersive VR in higher education (Radianti et al., 2020). This research identifies key design elements, evaluates lessons learned from existing applications, and proposes a future research agenda. Drawing from an extensive review of the literature across multiple databases, this study focused on the application of VR in diverse educational contexts. The researchers identified several critical design elements necessary for effective VR applications, such as user interaction, immersion levels, and pedagogical integration. The findings revealed that while VR offers significant potential for enhancing educational experiences, challenges remain, including technical limitations, user discomfort, and the need for more robust evaluation methods. The study concludes by recommending a research agenda that emphasizes the development of standardized design practices, improved assessment tools, and further exploration of VR's impact on learning outcomes. This research provides valuable insights into the current state of VR in higher education and lays the groundwork for future advancements.

In a study conducted by Radianti et al., titled "Learning effectiveness of immersive VR in education and training: A systematic review of findings," the research systematically examined the impact of immersive VR (IVR) on educational and training outcomes (Conrad, Kablitz, & Schumann, 2024). This study primarily aims to explore the impact of IVR—especially through HMDs—on learning effectiveness by comparing it to traditional and less immersive educational methods. The researchers performed an extensive review of peer-reviewed articles published between 2013 and 2018, focusing on studies that directly compared IVR with non-immersive learning methods. This study involved analyzing the cognitive, psychomotor, and affective learning outcomes reported in these studies, with particular attention to the design elements and experimental methodologies used. The findings indicate that while IVR can enhance learning experiences by providing immersive and interactive environments, its effectiveness in improving learning outcomes varies depending on the educational context and subject matter. The study also highlights several challenges, including the high cost of VR equipment and the need for specific technical skills to effectively implement VR in educational settings. The researchers conclude by recommending further investigation into the pedagogical strategies best suited for IVR as well as the development of more comprehensive evaluation tools to better assess the impact of IVR on learning outcomes. This systematic review contributes to the ongoing discourse on the role of advanced technologies in education and provides a foundation for future research in this field.

SUMMARY

VR in education and training. These studies all focused on the use of VR in education or training, highlighting its potential to enhance learning through immersive experiences. Studies generally point to challenges in implementing VR, such as high equipment costs, technical difficulties, and the need for more robust instructional frameworks. These studies have consistently evaluated the impact of VR on learning outcomes, particularly in the cognitive, psychomotor, and affective domains, exploring how immersive experiences can improve skill acquisition, engagement, and motivation. Some studies have focused on higher education, while others have examined the use of VR in sports training or in specific learning environments. Studies vary in their technological focus. Some studies emphasize head-mounted displays and motion capture systems, while others explore the combination of AR or mixed reality with VR. Findings vary depending on the context. For example, in sports training, VR has shown potential to improve athlete performance, whereas, in higher education, the effectiveness of VR is often limited by a lack of integration with solid learning theories. Most studies have found that VR has a positive impact on learning, particularly on engagement, motivation, and skill acquisition. The immersive nature of VR helps learners better understand complex concepts and imitate the movements of experts. A recurring finding is the need to better integrate VR with instructional theory. Without a solid theoretical foundation, the educational potential of VR cannot be fully realized. Research has also highlighted significant barriers to VR adoption, including the high cost of equipment and the specific technical skills required to effectively implement VR. Some studies pointed to a lack of theory-driven design in VR applications, leading to a greater focus on usability rather than educational outcomes. Research has also pointed to limited research on the long-term effects of VR on learning outcomes, particularly beyond the initial stages of skill acquisition. Another issue is the challenges associated with implementing VR in different educational settings, particularly in terms of scalability and accessibility.

2.6 RESEARCH GAP

1) Educational experience in VR:

Although existing studies have explored the application of VR technology in snowboarding training, few have analyzed the specific aspects of VR educational experiences, such as learning effects, learners' emotional responses to learning, cognitive load, and the impact of VR technology on learners of different ages and genders.

2) Customized learning content and individual differences:

The literature review mentioned that educational content should be tailored to learners' needs and abilities, but specific case studies or empirical studies are lacking to verify the practical impact of different types of customized learning content on learning outcomes, especially in skill-intensive activities such as snowboarding.

3) Educational experience and behavior change:

Existing research discusses how educational experiences influence learners' behavior and performance, but it remains poorly researched on long-term behavioral changes and habit formation. In particular, in the sports field, how to promote continuous behavioral change and healthy habits through educational experiences needs to be further explored.

4) Social interaction and learning motivation:

Although interaction is considered a key factor in improving learning motivation, the effect of specific social interactions on snowboarding learners' motivation and learning outcomes has not been defined. Research can further explore the impact of different types of social interactions (e.g., peer learning, competitive competition, etc.) on learner experience.

5) The integration effect of educational technology:

Although the literature discusses potential applications of educational technologies such as VR and augmented reality, there are few systematic evaluations of how these techniques are integrated with traditional teaching methods and their effectiveness and acceptance in practical teaching.

In-depth research in these areas allows a better understanding of aspects of educational experiences and their impact on learning outcomes, especially in skill-intensive and experience-rich teaching activities such as snowboarding. These research gaps provide directions for future research and contribute to the development of more effective teaching strategies and techniques.

2.7 CHAPTER SUMMARY

In this chapter, we explored multiple educational experience theories and models and their applications in teaching snowboarding. By analyzing the theories of constructivism, experiential learning, and social learning, this review highlights the importance of interaction, personalized learning, emotion, and attitude in educational experiences. Furthermore, this review discusses how enhancing teaching interaction and engagement through technologies such as VR and augmented reality, their application, and potential challenges in real-world educational settings.

We identified several research gaps, including the details of educational experiences in VR, experience in virtual reality, the specific effects of customized learning content, the impact of educational experience on long-term change in behaviour, the relationship between social interaction and learning motivation, and a comprehensive assessment of educational technology. These gaps provide directions for future research to optimize educational strategies and enhance educational effectiveness, especially in skills training such as snowboarding.

Through this literature review, we deepened our understanding of current educational experience theory and provided an empirical basis and theoretical guidance for future educational practice and research. Future studies could further explore applying these theories in specific educational scenarios and how to fully leverage the advantages of each theory through technology and innovative teaching methods to provide a more efficient and attractive learning experience.

CHAPTER 3

RESEARCH METHODOLOGY

This study used a mixed-methods research approach aimed at exploring and analyzing the effects of applying VR in the educational experience of beginner snowboarders. This method combined qualitative and quantitative research to fully understand and explain the learning experiences of beginner snowboarders in a virtual reality environment.

3.1 PARTICIPANTS

The participants were divided into the following seven groups:

Group 1: 12 snowboarding players, four snowboarding instructors, and four ski resort managers were randomly interviewed at the ski resorts.

Group 2: A total of 429 randomly selected audience members completed the online questionnaire.

Group 3: Three education experts, two virtual reality artists, and two human-computer interaction experts were interviewed in depth.

Group 4: The researchers conducted an online poll with 30 snowboarding enthusiasts to vote on the artistic style content.

Group 5: Four experts were involved in the design evaluation.

Group 6: A total of 15 participants were randomly recruited and selected as test subjects.

Group 7: Three snowboarding instructors were involved in evaluating test results.

This research involved four groups of experts (n = 11) selected based on recognized national or international purposive sampling principles.

The participating experts include professionals from the snowboarding instructors, virtual reality experts, human-computer interaction experts, technical experts, and experts in the field of education:

1) Snowboarding instructors

a. Song Bo

Title: Snowboard Instructor Diploma (Level 1)

(SWISS SNOWBOARD SCHOOL)

Level 1 Snowboard Instructor (CASI ACMS)

b. Teng Wei

Title: Snowboard Instructor Diploma (Level 1)

(SWISS SNOWBOARD SCHOOL)

Level 1 Snowboard Instructor (CASI ACMS)

c. Luca

Title: Snowboard Instructor Diploma (Level 1)

(SWISS SNOWBOARD SCHOOL)

Level 1 Snowboard Instructor (CASI ACMS)

2) VR technology and art experts

a. Yan Chenyu

Title: Professor

Major: Interactive and computer technologies

b. Lin Nan

Title: Assistant Professor

Major: Virtual reality environment design

c. Kevin Ang

Major: Graphical design, feature film animation, and motion graphic design

d. Takamitsu

Title: Assistant Professor

Major: Computer engineering

e. Zhang Luoxiao

Title: Professor

Major: Human-computer and digital music design

f. Yang Fan

Title: Assistant Professor

Major: New media and interactive design

3) Education experts

a. Chen Jifeng

Title: Professor

Major: Arts education

b. Shi Shuang

Title: Professor

Major: Adult education

c. Lan Wenfeng

Title: Professor

Major: Psychology education

3.2 DEFINITIONS OF SPECIFIC TERMS

"Edu-experience" denotes an amalgamation of "Education" and "Experience," referring to an educational or learning process facilitated through direct experience and participation. This term emphasizes experiential, personal involvement, and interactive learning in educational contexts, aiming to enhance the depth of understanding and the longevity of learning outcomes. Within the realm of virtual reality in snowboarding for beginners, edu-experience refers to a snowboarding experience created through virtual reality technology, which aims to teach snowboarding skills and incorporates artistic elements to enrich and elevate the learning experience.

“Snowboarding Beginners” refers to individuals who aspire to try snowboarding but cannot because of insufficient time and financial resources. These individuals typically have to juggle work, family responsibilities, and a livelihood in their daily lives. Even if they occasionally have the opportunity to go snowboarding, their time may not be sufficient, so they only have brief experiences. Therefore, they require a method that enables them to quickly and effectively learn the basic snowboarding techniques at a minimum cost and in a more convenient learning mode, maximizing their learning outcomes and experience quality within the limited time available. This approach allows people to quickly become accustomed to snowboarding when visiting a ski resort, resulting in a better overall experience.

VR integrates comprehensive artistic expressions into virtual reality technology to create immersive and interactive experiences that engage multiple senses. This involves using virtual reality to simulate artistic environments or incorporating design elements into virtual experiences. It emphasizes the holistic combination of technology and artistry to enhance the aesthetic and emotional impact of virtual reality content. Virtual reality also includes comprehensiveness, richness, engaging nature, and the ability to stimulate active participation through content design.

3.3 RESEARCH INSTRUMENTS

3.3.1 DATA COLLECTION INSTRUMENTS

1）Field observation

2）In-depth interviews with snowboarding players, snowboarding instructors, and ski resort managers

3）Questionnaire: audiences

4）Expert interviews

5）Experts’ evaluation questionnaire for Model 1

6）Pre-test questionnaire

7）Post-test questionnaire

8）User observation

9）Experts' evaluation questionnaire for Model 2

10）User skill test questionnaire

3.3.2 DATA COLLECTION AND ANALYSIS SOFTWARE

1. Online questionnaire system

2. Data analysis software

3. Camera

3.3.3 TECHNICAL SUPPORT TOOLS

VR headsets, computers, content creation software, VR platforms

3.4 EVALUATION OF THE VALIDITY OF RESEARCH TOOLS

To ensure the quality of the research instruments, the researcher invited three experts from other institutions to evaluate the instruments. By preparing a letter of introduction and recommendation from the Graduate School of Fine Arts, Silpakorn University, to request collaboration from experts. These three experts are:

a. Professor Wattana Jutavipard

Faculty of Digital Art, Rangsit University

b. Assistant Professor Dr. Kriangsak Khiaomang

Faculty of Fine and Applied Arts, Burapha University, Bangkok, Thailand

c. Dr. Miyoung Seo

Faculty of Fine and Applied Arts, Burapha University, Bangkok, Thailand

Three experts evaluated all research tools used in this study, including interviews, surveys, evaluation content, and test content, using the Index of Item Objective Congruence (Figure 19).

Figure 19
Interviews with IOC Experts

Note: This photo shows the interview process with IOC experts and illustrates the methodology used to gather expert evaluations of the research instruments.
Source: Photo by the author

The researchers asked experts to evaluate and score the alignment between the content of the research tool and the content of the research subject matter using the following rating scale:

+1: When the question is certain to be congruent.

0: When the congruence of the question is uncertain.

-1: When the question is certain to be not congruent.

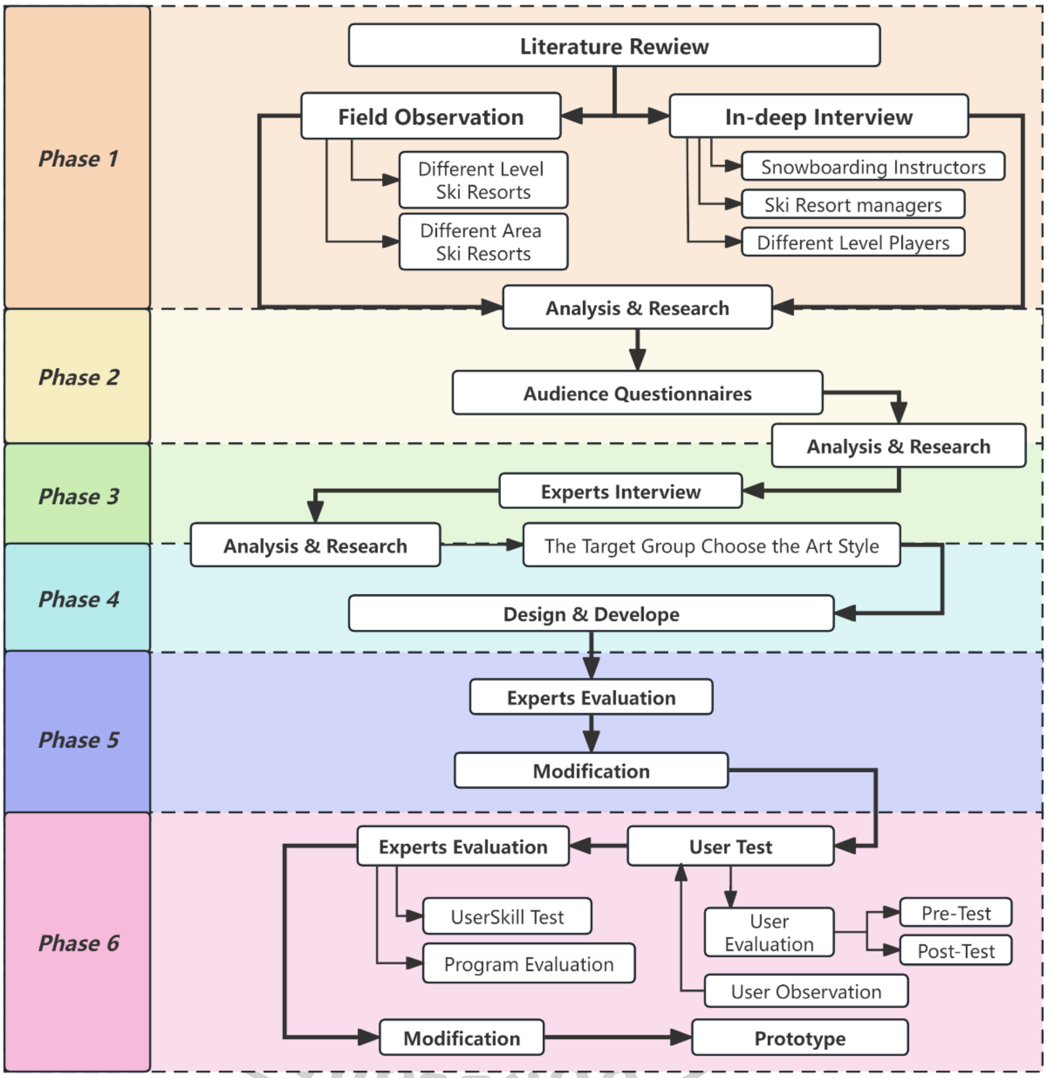
Data analysis shows that the IOC values of all research instruments are above 0.9, indicating a high degree of consistency with the research content. All three experts agreed on this assessment.

3.5 RESEARCH PROCESS

This was a combined research and development study, and the researchers divided the study into the following six phases (Figure 20):

Figure 20

Research Methodology and Process of the Study



Source: Created by the author

Phase 1: Through a literature review, the researchers identified and summarized the current status of snowboarding beginners. They conduct field observations at different levels of ski resorts in various regions to identify issues. In-depth interviews were conducted with snowboarding beginners, instructors, and operators to summarize the difficulties and challenges snowboarding beginners face. The analysis of these findings reveals snowboarding beginners' detailed educational experience needs for the first phase.

Phase 2: Based on the results of the first phase, the researchers designed a questionnaire for potential snowboarding beginners. This comprehensive survey gathers background information, experiences, expectations, and preferences of potential beginners. Analysis of the collected valid information leads to conclusions for the second phase.

Phase 3: The researchers conduct in-depth interviews with experts using the results from the second phase. The experts provide guidance and suggestions, evaluate the feasibility of the educational experience plan, and select appropriate technologies. The researchers designed an educational experience research framework for snowboarding beginners.

Phase 4: Before starting the design and development, researchers solicited opinions on the artistic style of the target users. The researchers designed and developed an educational experience research framework for snowboarding beginners. The design includes educational content and artistic elements from virtual reality. Development involves modeling, scripting, optimization, and internet integration, resulting in model 1.

Phase 5: The researchers will invite relevant experts to evaluate the initial model. Based on the feedback, we refine and iterate Model 1 to obtain Model 2.

Phase 6: Model 2 undergoes user experience testing. Users evaluated Model 2 using questionnaires, and the researchers observed user behavior. In this phase, professional snowboarding instructors are evaluators, assessing users' skill levels and evaluating the model. Finally, the researchers summarized and analyzed all the evaluation results to provide suggestions for improvement, resulting in the creation of the final prototype.

3.6 DATA COLLECTION

3.6.1 COLLECTING DATA THROUGH FIELD OBSERVATION

1) User Behavior and Emotional Responses

2) User Needs and Preferences

3) Interaction Patterns, Social Dynamics, and Communication

4) Learning Environment, Resource Utilization, and Facility Interaction

5) Effectiveness of Instructional Methods and Learning Resources

6) Comprehensive User Experience

3.6.2 COLLECTING DATA FROM IN-DEPTH INTERVIEWS

1）Player Interviews

The researchers conducted semi-structured interviews with players of different skill levels:

Experiences and Perspectives: Advanced and intermediate players shared insights from their experiences as beginners.

Progression: Description of progression from beginner to advanced stages, including challenges and successes.

Comprehensive Feedback: This step increased the reliability and representativeness of feedback by interviewing multiple skill levels.

Skill Improvement: Understanding the changes and needs in the players’ skill improvement processes.

2）Snow Resort Operators and Related Personnel Interviews

Researchers interviewed snow resort operators and related personnel:

Operational Perspective: Views on current teaching services for beginners.

Improvement Suggestions: Identify gaps and potential enhancements in teaching services.

3）Snowboarding Instructor Interviews

Researchers interviewed snowboarding instructors:

Teaching Methods: Effective methods and strategies for beginners.

Learning Challenges: Frequent issues faced by beginners and strategies to address them.

Learner Feedback: This step evaluates teaching effectiveness based on learner feedback.

3.6.3 COLLECTING DATA THROUGH AUDIENCE QUESTIONNAIRE

The questionnaire content was based on data obtained from preliminary field observations and in-depth interviews conducted by the researchers. To gather a broader range of perspectives and feedback, the researchers designed and distributed online questionnaires to collect data from a broad potential user base. The questionnaire covered the following aspects:

User Background: This study focuses on the demographic and experience levels of respondents.

Learning Experiences: Insights into respondents' past learning experiences in snowboarding.

Evaluation of Existing Educational Experiences: Feedback on current educational experiences and their effectiveness.

Mastery and Expectations of Educational Media: Assessing how healthy users understand and utilize existing educational media and their expectations for improvements.

3.6.4 COLLECTING DATA FROM EXPERT INTERVIEWS

Education Experts

Application and Effectiveness: Insights into the use of new technologies in education and their impact on teaching effectiveness and student learning experiences.

Teaching Methods and Strategies: Practical advice on interactive and motivating educational activities.

Feedback Utilization: Effective methods for collecting and using learner feedback to optimize teaching content and methods.

New Media Arts Experts

Virtual Reality Design: Insights into using visual effects and artistic styles to enhance learning content, immersion, and satisfaction.

User Interface Design: Recommendations for creating intuitive and attractive user interfaces.

Emotional Engagement: Using artistic elements to evoke emotion and enhance learning enjoyment.

Human-Computer Interaction Experts

User Interaction Design: Advice on designing intuitive, easy-to-use user interfaces.

Interaction Modes: Exploration of various interaction modes (e.g., gesture control, voice commands) and their effectiveness.

Usability Testing: Methods for usability testing and user behavior analysis to optimize interaction design.

Technology Implementation and Feedback Mechanisms

Technology Adaptability: Insights into how different learners adapt to new technologies.

Feedback Systems: Design and implement real-time feedback systems to enhance learning efficiency.

3.6.5 COLLECTING DATA THROUGH TARGET USER SELECTION OF THE ART STYLE

In this phase, target users vote on their preferred art styles. This ensures that the final design aligns with user preferences and adheres to this research’s core principle of user-centered design. It enhances their engagement and satisfaction with the educational experience. The collected votes will guide the selection of art styles to be incorporated into subsequent design and development stages, ensuring that the final product resonates with and attracts users.

3.6.6 COLLECTING DATA THROUGH EXPERTS' EVALUATION

The expert panel comprises education experts, virtual reality technology experts, human-computer interaction experts, and game design experts. They evaluated 10 aspects: educational value, interactivity, scene realism, player immersion, innovation, accessibility, diversity, scalability, and overall satisfaction.

3.6.7 COLLECTING DATA FROM USERS AND INSTRUCTORS

1) Pre-Test Questionnaire

The pre-test questionnaire assesses the following:

Essential Knowledge and Experience: Understanding subjects' backgrounds in snowboarding and virtual reality.

Expectations and Anticipations: Gauging subjects' expectations and anticipated difficulties in virtual reality education.

Attitudes and perceptions: Views on virtual reality technology in snowboarding education.

Expected Educational Outcomes: Understanding skill improvement and comprehension expectations.

2) Post-Test Questionnaire

The post-test questionnaire, which is based on the SAMR and Kirkpatrick Models, evaluates the impact of VR technology on educational outcomes, covering the following points:

Educational Experience: Virtual reality enhances learning outcomes and user experiences.

3) Subjects' Behavioral Observation Questionnaire

This questionnaire collected data on the subjects' reactions and behaviors during the virtual reality experience, focusing on the following points:

Interest Levels and Emotional Responses: Evaluating engagement and comfort.

Experience Duration and Success Rate: Assessing suitability and effectiveness.

4) Skills-Level Learning Outcomes Questionnaire

This questionnaire assessed the improvement in snowboarding skills after the VR experience, focusing on the following points:

Skill Mastery and Practical Application: Understanding changes in techniques and overall performance.

5) Snowboarding Instructor Evaluation Questionnaires

Instructors evaluated virtual reality educational methods compared to traditional methods using the Kirkpatrick and SAMR Models to assess:

Teaching Effectiveness and Technology Application: Insights into virtual reality's effectiveness and technical aspects in education.

3.7 DATA ANALYSIS

3.7.1 ANALYSIS OF FIELD OBSERVATION DATA

Field observations were conducted to understand user behavior and emotional responses, user needs and preferences, interaction patterns, social dynamics, communication, learning environment, resource utilization, facility interaction, the effectiveness of instructional methods and learning resources, and user experience. The following steps were taken to analyze these data:

Categorization: Observation notes were categorized based on the six aspects outlined in the UCD principles.

Thematic Analysis: Common themes and patterns were identified within each category to gain insights into user behaviors and preferences.

Behavioral Mapping: User interactions and movements within the learning environment were mapped to identify common patterns and areas that require improvement.

3.7.2 ANALYSIS OF IN-DEPTH INTERVIEW DATA

Data from in-depth interviews with experts and snowboarding players were analyzed as follows:

Transcription: All interview recordings were transcribed verbatim.

Coding: Transcriptions were coded to identify key themes and insights about user needs, preferences, and experiences.

Thematic Analysis: Themes were compared and contrasted across the interviews to identify shared insights and unique perspectives.

Expert Evaluation: The expert interview feedback was specifically analyzed to assess the effectiveness and comprehensiveness of the educational system.

3.7.3 ANALYSIS OF QUESTIONNAIRE DATA

The data collected through online and expert evaluation questionnaires were analyzed using the following methods:

Data Cleaning: Valid questionnaires were identified and organized. Invalid or incomplete responses were excluded from the analysis.

Descriptive Statistics: Basic statistics (mean, median, mode, frequency, percentage) were calculated to summarize the responses.

3.7.4 ANALYSIS OF EXPERT INTERVIEWS

Qualitative analysis will provide a detailed understanding of the experts' perspectives on various aspects of the educational system. The thematic analysis highlights key insights and common themes, enabling researchers to draw comprehensive conclusions and make informed recommendations for improving the educational experience for snowboarding beginners. This approach ensures that expert feedback is systematically analyzed and effectively utilized to enhance the overall effectiveness and usability of the educational system. Finally, experts evaluated the feasibility of each technology using a table format, marking feasible options. The technology that received the most checks was selected as the result.

3.7.5 ANALYSIS OF TARGET USER SELECTION OF ART STYLE

The data analysis during this phase utilizes a simple counting method to determine which art style received the most votes. Here is the detailed analysis method. By counting the number of votes each art style receives, the analysis will reveal the most preferred art style among target users. This method ensures that the selected art style reflects the majority's preferences, enhancing user engagement and satisfaction with the final educational experience. The straightforward counting and comparison of votes provide a clear and objective basis for the final selection of the artistic style.

3.7.6 ANALYSIS OF EXPERTS EVALUATION

The data collected through expert evaluations will be analyzed using descriptive statistical methods. Each aspect (educational value, interactivity, scene realism, player immersion, innovation, accessibility, diversity, scalability, and overall satisfaction) was rated on a Likert scale from 1 to 5, where 1 represents "very poor" and 5 represents "very good." The average and total scores for each aspect will be calculated to provide a clear quantification of expert opinions. Higher scores indicate stronger performance, whereas lower scores highlight areas for improvement. This systematic approach ensures a comprehensive and objective assessment of an educational system's effectiveness and usability based on expert evaluations.

3.7.7 ANALYSIS OF USERS AND INSTRUCTORS EVALUATION

The data collected through users and instructors will be analyzed using descriptive statistical methods. Each aspect was rated on a Likert scale from 1 to 5, where one represents “very poor” and 5 represents “very good.” The analysis includes the calculation of the average (AVG), median (MEDIAN), and standard deviation (SD) for each questionnaire.

1) Pre-Test Questionnaire

Essential Knowledge and Experience: Evaluate the background in snowboarding and virtual reality.

Expectations and Anticipations: The gauge of expectations and anticipated difficulty of virtual reality education.

Attitudes and perceptions: Views on virtual reality technology in snowboarding education.

Expected educational outcomes: Understanding expectations for skill improvement and comprehension.

Data Analysis: AVG, MEDIAN, and SD were calculated for each aspect to summarize the subjects’ initial knowledge, expectations, attitudes, and anticipated outcomes.

2) Post-Test Questionnaire

Educational Experience: Assess how virtual reality enhances learning outcomes and user experiences based on the SAMR and Kirkpatrick Models.

Data Analysis: AVG, MEDIAN, and SD were calculated for each aspect to evaluate the effectiveness of VR technology on educational outcomes.

3) Subjects’ behavioral observation questionnaire

Interest Levels and Emotional Responses: Evaluate engagement and comfort.

Experience Duration and Success Rate: Assess the suitability and effectiveness of the virtual reality experience.

Data Analysis: AVG, MEDIAN, and SD were calculated for each aspect to analyze subjects' reactions, behaviors, and overall experience during virtual reality sessions.

4) Skills-Level Learning Outcomes Questionnaire

Skill Mastery and Practical Application: Understanding changes in techniques and overall performance after the virtual reality experience.

Data Analysis: AVG, MEDIAN, and SD were calculated for each aspect to measure improvement in snowboarding and practical application abilities.

5) Snowboarding Instructor Evaluation Questionnaires

Teaching Effectiveness and Technology Application: This study provides insights into the effectiveness and technical aspects of virtual reality educational methods compared to traditional methods using the Kirkpatrick and SAMR Models.

Data Analysis: AVG, MEDIAN, and SD were calculated for each aspect to assess the instructors' evaluation of virtual reality's impact on teaching effectiveness and technology application.

Descriptive statistical analysis provides a clear and quantifiable measure of user and instructor feedback. The analysis highlights overall trends and response variations by calculating the average, median, and standard deviation for each aspect. High average scores indicate positive evaluations, whereas higher standard deviations suggest more significant response variability. This approach ensures a comprehensive and objective assessment of an educational system's effectiveness and usability based on user and instructor evaluations.

3.8 ETHICAL CONSIDERATIONS

Before commencing the study, the researcher obtained a certificate of ethical qualification for research involving human beings. The certificate number is # 0000851863. In this study, the researchers strictly adhered to ethical principles to ensure that the rights of all participants were respected and protected. The researchers invited each participant to sign an informed consent form before joining the study. The purpose, procedures, potential risks, and benefits of the study were also explained in detail to ensure that the participants understood that their participation was completely voluntary. All data collected were anonymized and accessed only by authorized research team members to ensure the confidentiality of the information.

3.9 CHAPTER SUMMARY

This chapter outlines the research methodology employed in this study, which focuses on exploring and analyzing the effects of applying VR in the educational experience of beginner snowboarders. A mixed-methods research approach was used, combining qualitative and quantitative techniques to gain a comprehensive understanding of the learning experiences of beginners in VR environments. The chapter details the study participants, including various groups such as snowboarding enthusiasts, instructors, and experts in VR and education who were involved in different phases of the research. Data collection methods included field observations, in-depth interviews, questionnaires, and expert evaluations. These improvements were supported by a variety of technical tools, including VR headsets and data analysis software. The validity of the research instruments was ensured through evaluations by external experts, and the data collected was analyzed using thematic analysis and descriptive statistical methods. The chapter also emphasizes ethical considerations, ensuring that all participant data were anonymized and informed consent was obtained. The research process was structured into six phases, ranging from literature review and needs analysis to the development and testing of a VR-based educational framework for snowboarding beginners. The results from these phases provide insights into user behaviors, learning outcomes, and the effectiveness of VR as a teaching tool.

CHAPTER 4

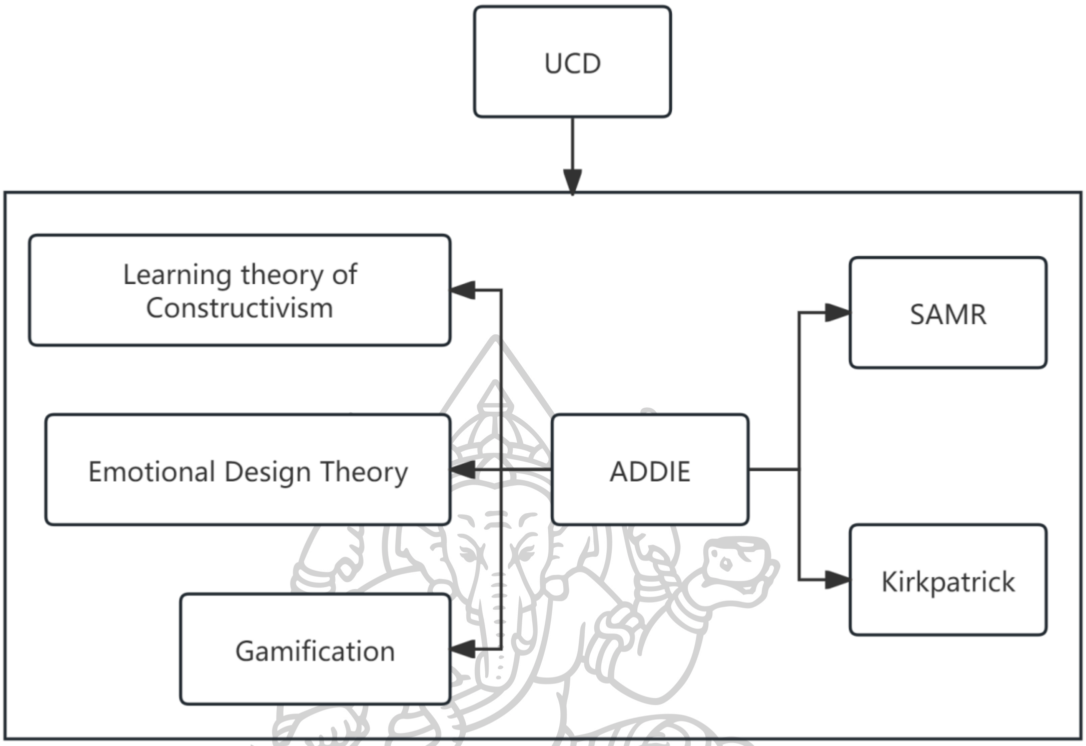
DATA ANALYSIS

This study aimed to design an educational experience model for snowboarding beginners that introduces an innovative teaching pathway. The researchers achieved this objective for the study using user-centered design (UCD) principles as the guiding framework for both design and development, ensuring that the research and development processes were consistently centered around user needs. The researchers based the entire study on the ADDIE Learning Model, which involves analysis, design, development, implementation, and evaluation. Additionally, the study integrated Constructivist Learning Theory, Emotional Design Theory, and Gamification concepts to create a complete educational experience. The SAMR Model was used to evaluate the educational outcomes for the users, while the Kirkpatrick Model was employed to assess user experience. The conceptual framework of the design is illustrated in the following figure (Figure 21).

The researchers deeply and meticulously analyzed the entire educational experience needs of snowboarding beginners, including their learning needs, preferences, and challenges, using various research methods such as field observations, in-depth interviews, and questionnaires. The collection and analysis of the data provided a solid foundation for the subsequent design of the educational experience framework. The researchers translated these findings into practical educational experience content designs. They ensured that the designed educational experience met theoretical requirements while aligning with actual user needs. This process included prototyping, user testing, and iterative improvement based on feedback.

Figure 21

The Design Research Conceptual Framework



Source: Created by the author

This chapter details each step of the design research, from explaining how existing theories and models were utilized to the initial data collection and analysis, culminating in a final summary of the educational experience model for snowboarding beginners. This process demonstrated how the study created a new paradigm focused on the educational experiences of snowboarding beginners.

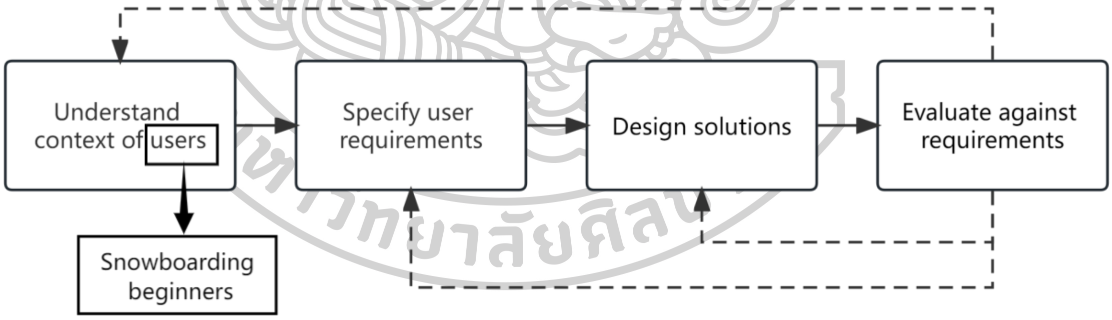
4.1 THE RESEARCH FRAMEWORK OF VIRTUAL REALITY IN THE EDU-EXPERIENCES OF SNOWBOARDING BEGINNERS

This section details how the researchers used the models and theories within the research framework and highlights the significance and role of these models and theories in guiding the research.

4.1.1 UCD SERVED AS A CORE GUIDING METHOD FOR THE ENTIRE RESEARCH

In this study, the principles and methodologies of user-centered design (UCD) were crucial in guiding the researchers throughout the research and development process. The core idea of UCD was to prioritize user needs and experiences, center design decisions around user experience, and emphasize a user-first design approach (Norman & Draper, 1986). Every stage of design and development focused on the users' needs and feelings, creating an educational experience system centered around the users rather than forcing them to adapt to the system or change their usage habits (Figure 22). This concept profoundly influenced every step the researchers took, from research design to data collection, analysis, and development. The study focused on documenting the specific needs, preferences, and challenges faced by snowboarding beginners.

Figure 22
UCD Conceptual Framework



Source: Created by the author based on the user-centered design concept

4.1.2 THE ADDIE LEARNING MODEL SERVED AS THE FOUNDATION OF THE STUDY

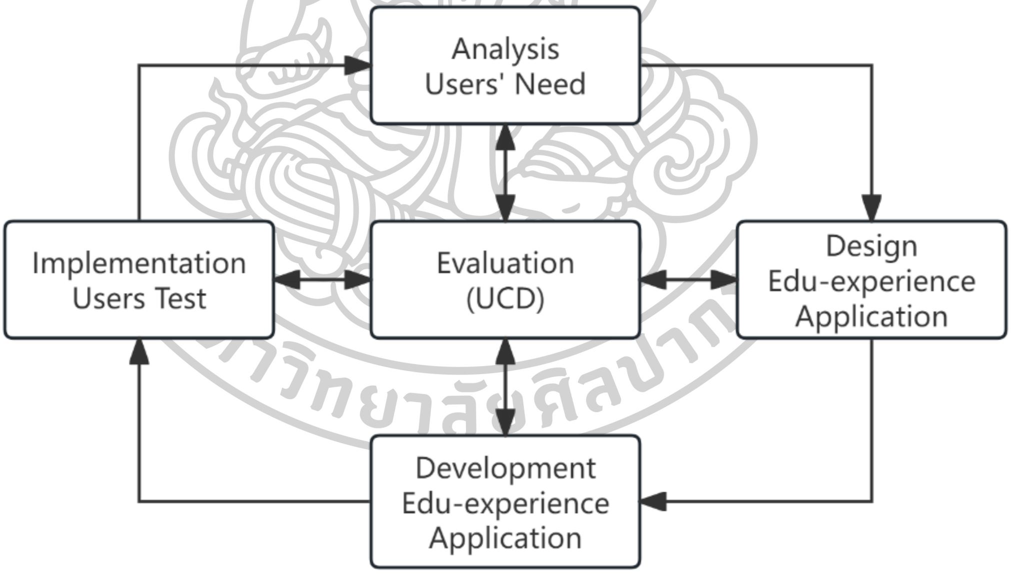
The ADDIE Model is an iterative guiding process that aligns with user-centered principles in UCD. The evaluation phase encompasses five phases: analysis, design, development, implementation, and evaluation. The researchers used the ADDIE

Model in this study to help ensure a systematic and comprehensive design of the educational experience (Figure 23).

In the analysis phase, the researcher used a literature review, field observations, questionnaires, in-depth interviews, and other methods to understand the needs, characteristics, and prior knowledge of the target users.

During the design phase, the researchers planned a specific program for experimentation and development, including the initial design of instructional materials and assessment tools. The researchers developed detailed teaching strategies, learning activities, assessment methods, and course structures, designed syllabi and course maps, and created prototypes and sketches.

Figure 23
The ADDIE Model Conceptual Framework for Snowboarding Beginners



Source: Created by the author

The development phase involves creating the edu-experience components, including course content, software, and instructional tools. The researcher creates or collects instructional materials, media, and technological resources. The researchers tested the developed materials and modified them to ensure quality.

During the implementation phase, the researcher prepares the edu-experience environment and the learners. They also implemented an educational program, which included training staff, providing resources for learners, and finding suitable testing sites. The researchers monitored the implementation process and resolved technical and administrative issues. This phase involved deploying the educational experience in an experimental or pilot setting and ensuring all participants understood their roles and responsibilities.

The assessment had multiple phases in the evaluation session: analysis, design and development, and testing were evaluated separately. This evaluation approach is in line with the UCD principle. Corresponding expert and user assessments are conducted at each stage to ensure the entire model is fully effective for the user. The evaluation results adjusted the instructional design to enhance the learning experience. Summative assessment, which includes assessment results and learning outcomes and compares them to the original learning objectives and needs, can help with continuous improvement and iteration.

4.1.3 DESIGN OF EDUCATIONAL EXPERIENCE CONTENT

4.1.3.1 CONSTRUCTIVIST LEARNING THEORY

Constructivist Learning Theory is a pedagogical theory that emphasizes learning as an active, constructive process in which learners actively construct or build their knowledge and understanding. It values the active participation and personal experience of learners.

When designing the edu-experience activities, the researchers designed the environment and interaction methods to simulate fundamental snowboarding so that the learners could learn and practice their skiing skills through practical operation. The researchers provided opportunities for learners to learn independently through exploration and experimentation. We designed inquiry-based tasks to help students discover the principles and best practices of snowboarding skills. The researchers identified snowboarding technique problems for learners to analyze and propose solutions. Moreover, we established an online community to encourage learners to cooperate with others and share their knowledge and experiences. Encourage learners to reflect on their learning processes and outcomes to promote deeper understanding. We considered learners' existing knowledge and experience when designing the content.

4.1.3.2 EMOTIONAL DESIGN THEORY

Emotional design theory emphasizes the importance of design that not only meets the functional needs of users but also focuses on the importance of triggering emotional responses from users. This theory advocates that design should touch the emotional level of users, evoke positive emotional experiences, engage users, and increase user satisfaction and loyalty.

In this study, the researchers designed a visually appealing and intuitive virtual reality interface using engaging graphics and colors to attract learners. High-quality images, apparent sound effects, and realistic simulated environments were used to spark learners' curiosity and interest. Ensured that the interactive design of the virtual reality application was intuitive and smooth, making it easy for learners to understand how to operate the virtual environment. We created learning activities that connect with learners' interests and experiences. Storytelling and scenario simulations were used to add emotional depth to the learning content, thus making the learning experience more meaningful and memorable.

4.1.3.3 GAMIFICATION

Gamification applies game design elements and principles in non-game environments to increase user engagement, motivate behavior, facilitate learning, and influence action. In education, gamification makes learning experiences more enjoyable and interactive, thus increasing learners' engagement and motivation. In this study, the researchers allowed learners to play specific roles in a virtual environment to enhance immersion. The relaxation session was designed to prevent the fatigue that the learning activity might cause.

4.1.3.4 SAMR MODEL

The SAMR Model, developed by Dr. Ruben Puentedura, is a framework designed to help educators integrate technology into teaching and learning. SAMR stands for Substitution, Augmentation, Modification, and Redefinition. It provides a way to assess and evaluate the impact of technology on teaching and learning.

Researchers using the SAMR Model aim to assess the impact of technology on learning experiences, enhance learning outcomes, and introduce innovations in teaching methods. The researchers applied all layers of SAMR to conduct the assessment.

In the substitution layer, whether the technology replaced traditional methods or brought new features or benefits. The Enhancement Layer identified whether the technology provided additional benefits by enhancing the efficiency of the teaching or learning experience. In the modification layer, we assessed whether the technology changed the nature of the learning task. In the reinvention layer, whether the technology created entirely new learning styles and experiences was examined. Researchers collected feedback from learners and experts through questionnaires, interviews, observations, and data analysis. Assess their perceptions of the use of technology, especially its impact on learning motivation, engagement, and effectiveness. Moreover, the collected data will be analyzed to determine the position and effectiveness of the technology application in the SAMR Model. Identify what is working well, what needs to be improved, and how to move up to a higher SAMR level. Based on the assessment results, suggest ways to improve the use of technology to enhance the quality of teaching and learning. Consider introducing new technology tools and methods or changing instructional designs and practices.

4.1.3.5 KIRKPATRICK MODEL

Considering that the focus of this study was on the educational experience of snowboarding beginners in virtual reality, the researchers evaluated the design of the edu-experience using the Kirkpatrick Model, as it considers both the multiple aspects of the educational experience, as well as the feedback and user outcomes (learner). The Kirkpatrick Model provides a comprehensive framework for evaluation, covering everything from learners' immediate reactions to the application of learning outcomes. This study deals with the use of VR technology in education; thus, the Kirkpatrick Model can help assess this technology's direct and indirect impact on teaching and learning outcomes. Evaluate learners' reactions to the virtual reality snowboarding tutorial (e.g., whether they enjoyed it or they found the helpful content). Higher levels of the model can help assess whether learners apply the skills they learned in the virtual environment and how this affects their long-term snowboarding skills. The results of the Kirkpatrick Model assessment can be used to identify strengths and weaknesses in the instructional design to make improvements.

Assessment was carried out at four levels of the model. The first level collected learners' feelings and satisfaction with the virtual reality course. At the second level, tests and practical demonstrations were used to assess whether learners mastered the skills taught in the course. At the third level, learners were observed to determine whether they applied the skills they learned in the virtual environment to actual skiing. At the fourth level, the long-term impact of the entire program on the learners' skiing skills was assessed, as well as whether the educational objectives were met.

4.1.4 THE DESIGN RESEARCH CONCEPTUAL FRAMEWORK FOR THE EDU-EXPERIENCE FOR SNOWBOARDING BEGINNERS

The researchers designed a conceptual framework for the educational experience of snowboarding beginners using the aforementioned models and theories. They thoroughly analyzed the characteristics, prior knowledge, educational needs, experiential needs, and technology choices of target users. Guided by user needs, the design was advanced by integrating Constructivist Learning Theory, Emotional Design Theory, and Gamification Theory, aiming to create a comprehensive and interactive learning environment.

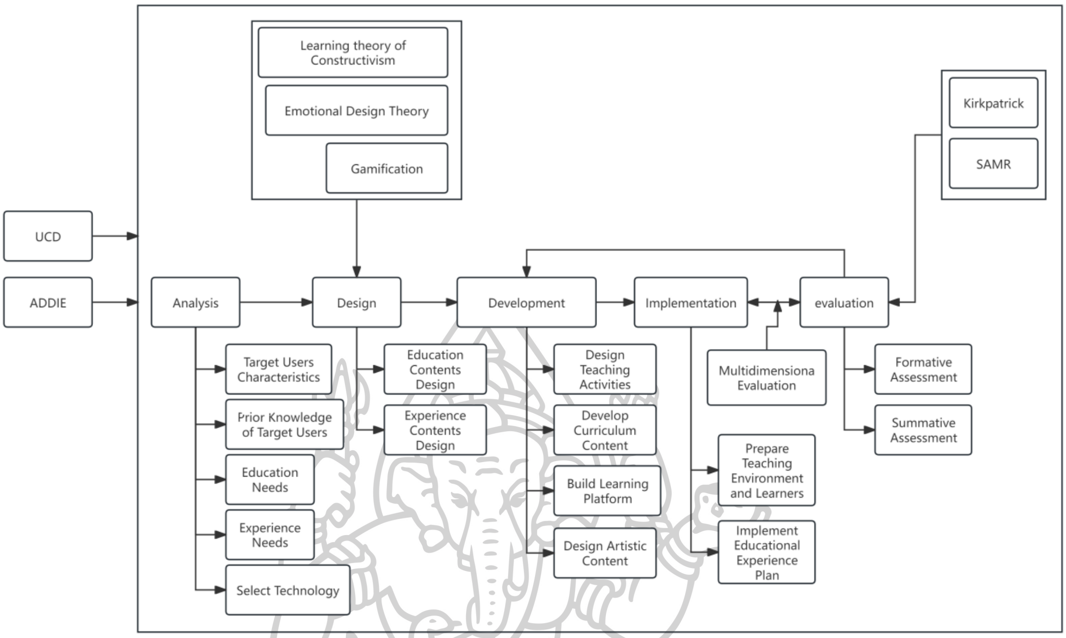
In the design phase, the researchers planned to create a learner-centered interactive learning environment. This environment not only included rich instructional content but also employed gamification to motivate learners. For example, by earning points and rewards for completing tasks, learners can receive continuous positive feedback and maintain high levels of interest and motivation during the learning process. The researchers developed various learning resources, including text, videos, and interactive media, to meet the needs of different learners.

The implementation phase involved applying these resources and designs to actual teaching to ensure that learners could smoothly conduct their learning through a virtual reality platform. In the evaluation phase, the researchers planned to use the Kirkpatrick and SAMR Models to measure the effectiveness of the teaching. Through evaluations of the reaction, learning, behavior, and results levels, the researchers can comprehensively understand the effects of the educational program and make continuous optimizations and improvements based on feedback. Additionally, the SAMR Model helped evaluate the depth and effectiveness of technology integration, from simple substitution tools to transformative teaching practices, ensuring that the application of educational technology truly enhanced learning experiences and outcomes.

This systematic conceptual framework effectively improved the skill levels and learning experiences of snowboarding beginners (Figure 24). It not only focused on technology and interactive design but also emphasized learners’ emotional experiences and motivation. The ultimate goal was to provide innovative and efficient solutions for snowboarding education while also offering valuable references and insights for educational design in other fields.

Figure 24

The Design Research Conceptual Framework for the Edu-Experience for Snowboarding Beginners



Source: Created by the author

4.2 DATA COLLECTION

The data collection was performed in the following five stages:

First Phase: The researchers initially collected the educational experience needs of snowboarding beginners through field observations and in-depth interviews.

Second Phase: Based on the results from the preliminary data collection, the researchers conducted a comprehensive online survey to further expand the data scope and sample size.

Third Phase: Using the data gathered from the previous phases, the researchers interviewed experts in related fields to obtain final and in-depth insights.

Fourth Phase: After completing the design and development, the researchers gathered expert evaluation feedback to iterate and optimize the model.

Fifth Phase: The researchers collected assessments and feedback from the participants as well as evaluations from experts on the beginners' performance.

4.2.1 DATA COLLECTION FOR THE FIRST PHASE

4.2.1.1 FIELD OBSERVATION: FIRST STEP TO IN-DEPTH USER EXPERIENCE

Field observation, as a key component of user-centered design (UCD), provided this study with the opportunity to gain direct insights into user needs. Five ski resorts from different countries and regions were selected for observation. The objectives were as follows:

1) Consideration of Cultural Differences: Snowboarding cultures may vary significantly across countries and regions. By observing multiple countries and regions, researchers were able to understand how these cultural differences influenced the learning experience and teaching methods of snowboarding.
2) Diverse Learning Environments: Each ski resort’s environment, facilities, and services may differ. Observing multiple locations helped researchers capture the learning experiences and challenges under different conditions.
3) Broad User Experience: Snowboarding beginners in different regions may have diverse backgrounds, skill levels, and learning needs. Observations across multiple regions provided broader user experience data, enhancing the study’s generalizability and applicability.
4) Comparison of Teaching Methods: Snowboarding instructors in different regions use different teaching methods and styles. Comparing these different approaches helped identify the most effective methods in different environments.
5) Exploration of Adaptability and Universality: Observing practices in different regions helped researchers design educational experience frameworks that were adaptable to specific cultures and environments and universally applicable.

By using this multi-location and multi-cultural research method, researchers gained more comprehensive and in-depth insights, which were crucial for designing a widely applicable and effective educational experience system. According to UCD principles, researchers focused on the following six aspects:

1) User Behavior and Emotional Responses: Merging “user behavior and reactions” with “emotional responses and engagement,” focusing on the specific behaviors of beginners during the learning process, including their reactions to challenges, failures, and successes, as well as their emotional changes and engagement in different situations.
2) User Needs and Preferences: We focus on the needs and preferences expressed by users during the learning process, such as specific requirements for instructional content, methods, and learning environments.
3) Interaction Patterns, Social Dynamics, and Communication: Combining “interaction and communication patterns” with “social dynamics and group interaction,” focusing on the interactions between beginners and instructors, other learners, and ski resort staff, including how they supported each other, exchanged experiences, and built social connections during the learning process.
4) Learning Environment, Resource Utilization, and Facility Interaction: Combining “learning environment and resource utilization” with “use of environment and facilities,” focusing on the learning environment of the ski resort, the quality of equipment, the layout of the site, and how learners interacted with these environments and facilities, including their responses to accessibility and availability.
5) Effectiveness of Instructional Methods and Learning Resources: The effectiveness of existing instructional methods and learning resources was evaluated and how they helped or hindered the learning process.

6) Comprehensive User Experience: Gaining a holistic understanding of the learning experience from the user's perspective, including preparations before snowboarding, experiences during snowboarding, and feelings after the course.

By focusing on these aspects, researchers can gain a deeper understanding of users' experiences and needs, thereby designing more effective educational experiences that meet user needs within the UCD framework.

4.2.1.2 IN-DEPTH INTERVIEWS: COLLECTING USER INSIGHTS FROM MULTIPLE PERSPECTIVES

1) Player Interviews

After completing the field observations, the researchers conducted semi-structured interviews to gain a deeper understanding of the experiences and perspectives of the players at different levels. Players with different levels of experience provided diverse feedback. Advanced and intermediate players start as beginners, and their progression offers valuable insights. From their "experienced" perspective, they can provide mature advice based on their journey from beginner to advanced levels. Interviewing players of different levels increased the reliability and representativeness of the study, ensuring that the feedback collected was comprehensive and objective. This multi-layered dialog helped the study fully understand the changes and needs of the players during their progression in snowboarding skills.

2) Ski Resort Operators and Other Related Personnel Interviews

The study also involved interviews with ski resort operators and other personnel to understand their views on the educational experiences of beginners and potential improvements. These interviews helped the study understand the operational aspects of instructional services and identify areas for potential enhancement from an operational perspective.

3) Snowboarding Instructor Interviews

As key figures in the instructional process, snowboarding instructors provided crucial insights into understanding the teaching process and learning challenges. Through in-depth discussions with the participants, the researchers obtained valuable information about instructional methods, common issues, and learner feedback.

4.2.2 DATA COLLECTION FOR THE SECOND PHASE

The researchers based the content of the questionnaires on data and insights gathered from prior field observations and in-depth interviews. To obtain a broader range of perspectives and feedback, the researchers designed and distributed online questionnaires to collect data from a more extensive user base. These questionnaires covered various aspects, including users' backgrounds, learning experiences, evaluations of existing educational experiences, mastery, and expectations of educational mediums. By analyzing these data, the researchers could identify common issues and user needs more accurately, providing a crucial basis for subsequent design work.

4.2.3 DATA COLLECTION FOR THE THIRD PHASE

This part involves interviews with experts, including education experts, new media art experts, and human-computer interaction experts. The purpose of collecting these expert opinions is to:

1) Validate and Refine the Theoretical Framework

Education experts have extensive teaching practice experience. By communicating with them, researchers can validate the feasibility and effectiveness of theories and models in teaching. Feedback and suggestions from experts can help researchers identify and address gaps between theory and practice, thus refining and enriching the theoretical framework.

2) Obtain Practical Advice and Best Practices

Education experts can provide effective teaching methods and strategies accumulated in their practice and offer concrete guidance for educational design for snowboarding beginners. Understanding experts' experiences when using new technologies in teaching can provide valuable references for researchers when selecting and applying educational technologies and avoid potential pitfalls and mistakes.

3) Identifying and Overcoming Challenges

Experts can share the challenges and solutions they encounter when implementing new technologies and help researchers anticipate and address potential issues in advance. Through expert feedback, researchers can optimize teaching design and implementation strategies, ensuring the smooth application of new technologies in teaching and achieving desired outcomes.

4) Gaining Diverse Perspectives and Innovative Ideas

Engaging with experts from different fields (such as new media art and human-computer interaction) can introduce diverse perspectives and innovative ideas into educational design and enhance the richness and creativity of the educational experience.

Experts usually have access to the latest educational technologies and methods. Interactions with them allow researchers to understand and apply these cutting-edge technologies, enhancing innovation and advancing educational design.

5) Enhancing the Scientific Rigor and Authority of the Research

Citing expert opinions and suggestions can enhance the scientific rigor and authority of the research, making the study more rigorous and credible. Expert feedback acts as a form of peer review, helping researchers identify shortcomings and areas for improvement, thereby enhancing the overall quality of the study.

The researchers collected expert opinions on the following aspects:

1) Opinion Scope of Education Experts

Through interviews with education experts, the researchers were able to understand the experiences and effects of applying new technologies in education. The researchers gained in-depth insights into the experts' experiences using new technology tools in teaching and explored how these technologies enhanced teaching effectiveness and student learning experiences. They also received practical advice on teaching methods and strategies, including designing highly interactive and motivating educational activities. Additionally, they discussed how to effectively collect and utilize learner feedback to optimize teaching content and methods and ensure the achievement of educational goals.

2) Opinion Scope of New Media Art Experts

The researchers obtained valuable insights into applying new media art design to virtual reality environments through interviews with new media art experts. Experts discussed how to design visual effects and artistic styles to make learning content more vivid and engaging, thus enhancing learners' immersion and satisfaction. Researchers also learned how to optimize user interface designs to be user-friendly and attractive while using artistic elements to evoke emotional resonance in learners, thus increasing enjoyment and engagement during learning.

3) Scope of Opinions from Human-Computer Interaction Technology Experts

Through interviews with human-computer interaction technology experts, the researchers gained an in-depth understanding of professional insights into user interaction design and technology usability. Experts advised on designing intuitive and easy-to-use user interfaces to ensure learners could efficiently interact with virtual reality environments. The researchers also explored the application and effects of various interaction modes (such as gesture control and voice commands). They also learned about conducting usability testing and user behavior analysis to optimize interaction design and ensure the practical application of the technological tools.

4) Technology Implementation and Feedback Mechanism

During the interviews, the researchers focused on designing technology adaptability and feedback mechanisms. Experts shared the adaptation experiences of different learners to new technologies and discussed how to adjust and optimize technology application strategies to better serve educational goals. Researchers also discussed how to design and implement real-time feedback mechanisms to help learners receive timely feedback and guidance during the learning process, thereby improving learning efficiency.

Through these interviews, the researchers were able to comprehensively understand the perspectives and experiences of experts in their respective fields, providing a solid theoretical and practical foundation for educational experience design for snowboarding beginners. These expert opinions will assist researchers in designing more compelling educational experiences that meet user needs within the UCD framework.

4.2.4 FOURTH-PHASE DATA COLLECTION: TARGET USER SELECTION OF THE ART STYLE

In this phase, target users vote on their preferred art styles. This ensures that the final design aligns with user preferences and adheres to this research's core principle of user-centered design. It enhances their engagement and satisfaction with the educational experience. The collected votes will guide the selection of art styles to be incorporated into subsequent design and development stages, ensuring that the final product resonates with and attracts users.

4.2.5 EXPERT EVALUATION OF VIRTUAL REALITY EDU-EXPERIENCE APPLICATION

The expert panel consisted of education experts, virtual reality technology experts, human-computer interaction experts, and game design experts. They evaluated the product from 10 aspects: educational value, interactivity, scene authenticity, player immersion, innovation, accessibility, diversity, scalability, and overall satisfaction. They also provided suggestions for improvements.

These expert evaluations aimed to comprehensively and systematically assess various aspects of the product to ensure its quality and effectiveness. Each aspect corresponds to different evaluation dimensions, reflecting the product's performance in terms of realism, interactivity, educational value, user experience, and more. Below are the specific contents of each evaluation aspect and their importance:

1) Scene Authenticity

How well does the scene design reflect the natural snowboarding environment and experience? High authenticity enhances learners' immersion and learning outcomes, allowing them to experience virtual environments that are similar to real environments.

2) Interactivity

The number of interactive elements provided in the scene and their effectiveness in promoting player engagement and learning. High interactivity increases user engagement and hands-on ability, encouraging active participation in learning and improving learning outcomes.

3) Educational Values

The extent to which scene design helped players learn and master snowboarding skills. Achieving high educational value is the core goal of a product. High educational value means that the product can effectively teach snowboarding techniques and improve users' skill levels.

4) Player Immersion

The extent to which scene design enhances player immersion and game experience. High immersion increases user engagement and focus, making users more involved in learning and practicing, thus improving learning outcomes.

5) Innovation

How scene design performs in terms of innovation and creativity. Innovation can attract user interest, provide a unique learning experience, and avoid the monotony of the learning process.

6) Accessibility

Whether the scene is easy for beginners to understand and enter while being challenging for experienced players. High accessibility ensures that players of different levels benefit, allowing beginners to get started while experienced players find challenges and enjoyment quickly.

7) Diversity

Whether the scene design offers enough variety and diversity to keep players interested and engaged, diversity prevents users from getting bored and continuously attracts their interest and participation, thus improving the continuous learning and practice effects.

8) Visual and Sound Effects

The extent to which the scene's visual design and sound effects enhance the game experience. Excellent visual and sound effects can enhance user immersion and overall experience, thereby making learning more enjoyable and memorable.

9) Scalability

Whether the scene design allows for the easy addition of new content such as new tasks, skills, or instructional elements, high scalability ensures that a product can be continuously updated and improved to meet users' evolving needs and interests, thereby maintaining its long-term appeal.

10) Overall Satisfaction

The experts' overall satisfaction with the design. Overall satisfaction reflects the experts' comprehensive evaluation of the product, which encompasses all the above aspects.

4.2.6 EVALUATION AND FEEDBACK FROM BEGINNERS AND THE EXPERT ASSESSMENT OF BEGINNERS' PERFORMANCE

1) Pre-test Questionnaire for Subjects

The researchers used the pre-test questionnaire to comprehensively evaluate the following aspects:

Essential Knowledge and Experience Background: The subjects' foundational knowledge and experience in snowboarding and virtual reality.

Expectations and Anticipations: The participants will gauge their expectations and anticipated difficulties regarding virtual reality education, which will help set appropriate instructional content and methods.

Attitudes and Perceptions: The participants were assessed on virtual reality technology in snowboarding education, including whether it could spark interest and boost confidence.

Expected educational outcomes: The participants will understand their expectations for the effectiveness of virtual reality education, including improvements in skill mastery and comprehension levels.

2) Post-test Questionnaire for Subjects

The post-test questionnaire was designed based on the SAMR Educational Evaluation Model and the Kirkpatrick Experience Evaluation Model. The purpose was to comprehensively assess users' educational experience outcomes and ensure that the application of VR technology effectively enhances learning outcomes and experiences. The questionnaire questions corresponded to different levels of the SAMR Model and the Kirkpatrick Model to evaluate how VR technology influenced educational practices.

4.2.6.3 BEHAVIORAL OBSERVATION QUESTIONNAIRE FOR SUBJECTS

This questionnaire aimed to collect data on subjects' behaviors and psychological responses when using the virtual reality experience project. The questionnaire focused on the participants' levels of interest, emotional reactions, comfort, appropriateness of session length, and success rate of the experience. These data helped researchers evaluate user experiences and the effectiveness of the VR experience project. This allowed researchers to comprehensively understand the various reactions and experiences of users during virtual reality sessions, thereby optimizing and enhancing the design and functionality of the project to better meet user needs and provide a high-quality experience.

4.2.6.4 SKILL LEVEL LEARNING OUTCOMES QUESTIONNAIRE FOR SUBJECTS

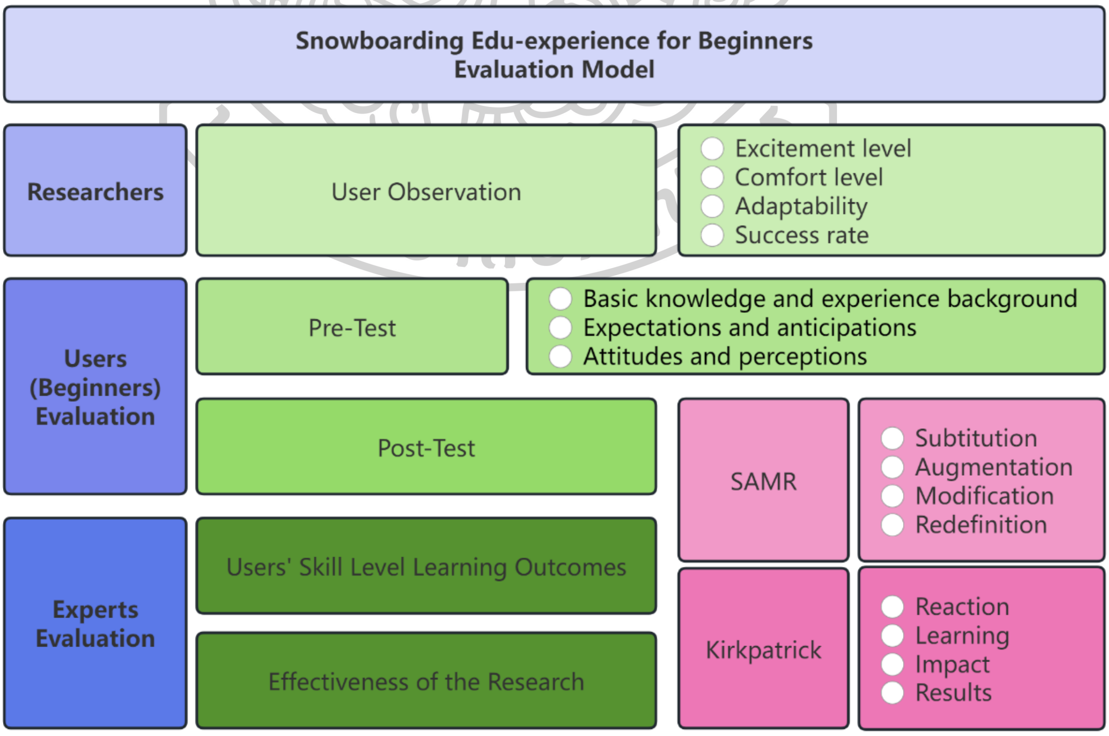
The primary purpose of the Skill Level Learning Outcomes Questionnaire was to evaluate subjects' progress and mastery of snowboarding skills after completing their virtual reality educational experience. The questionnaire focused on the specific outcomes of skill learning, including changes in the participants' snowboarding techniques, practical application abilities, and overall performance. These questions aimed to understand the subjects' mastery of basic snowboarding skills after their virtual reality educational experience and assess their ability to apply the learned techniques to actual snowboarding. By analyzing these responses, researchers could comprehensively understand the effectiveness of virtual reality learning experiences in improving subjects' snowboarding skill levels and provide data support for further optimization and improvement of educational content and teaching methods.

4.2.6.5 SNOWBOARDING INSTRUCTOR EVALUATION QUESTIONNAIRE FOR THE ENTIRE PROJECT

The questionnaire designed for instructors can focus more on evaluating the technical aspects and teaching effectiveness of virtual reality education and comparing its advantages and disadvantages with those of traditional methods. Additionally, it assesses whether the study effectively reduces learning costs for beginners and helps learners quickly transition to real-world snowboarding skills. For instructors, researchers used the Kirkpatrick Model to evaluate educational effectiveness and the SAMR Model to assess the levels of technology application. The professional backgrounds of instructors enable them to provide in-depth insights into teaching effectiveness and technology applications.

The researchers created an evaluation model for the project that was about to be tested (Figure 25).

Figure 25
The Evaluation Model



Source: Designed by the author

4.3 DATA ANALYZATION OF EDUCATIONAL EXPERIENCE NEEDS OF SNOWBOARDING BEGINNERS

4.3.1 DATA ANALYSIS OF THE FIRST PHASE

The researchers selected five different types of ski resorts for on-site observation and interviews. Different types of ski resorts have different target user groups. The purpose of selecting these resorts was to gain a more comprehensive understanding of the needs and behavioral patterns of various users. By doing so, the researchers aimed to collect diverse data, thereby enabling a more accurate analysis and understanding of user groups' experiences and needs at ski resorts. This not only helped in developing more targeted services and teaching plans but also provided more effective improvement suggestions for the management and operation of ski resorts.

1) ICE MAGIC

An indoor snow park event held in various cities, including Bangkok, aims to provide a winter wonderland experience during the hot summer. The Bangkok edition took place at The Market Bangkok, covering an area of 3,000 square meters within an 11.5-meter-tall tent. The event featured various winter activities and zones designed to appeal to visitors of all ages. Key features included the Snow Zone, which used advanced snow-making machines from the Beijing 2022 Winter Olympics to create fresh snow daily, featuring an 80-meter-long snow slope, the longest in Thailand, where visitors could ski and snowboard. The Ice Zone included a 300-square-meter ice skating rink, a two-lane, 148-meter-long ice slide, and intricate ice sculptures created by artists from the Harbin Ice Festival (Figure 26).

Figure 26

Field Observation and Interview Processes at Ice Magic Indoor Snow Park

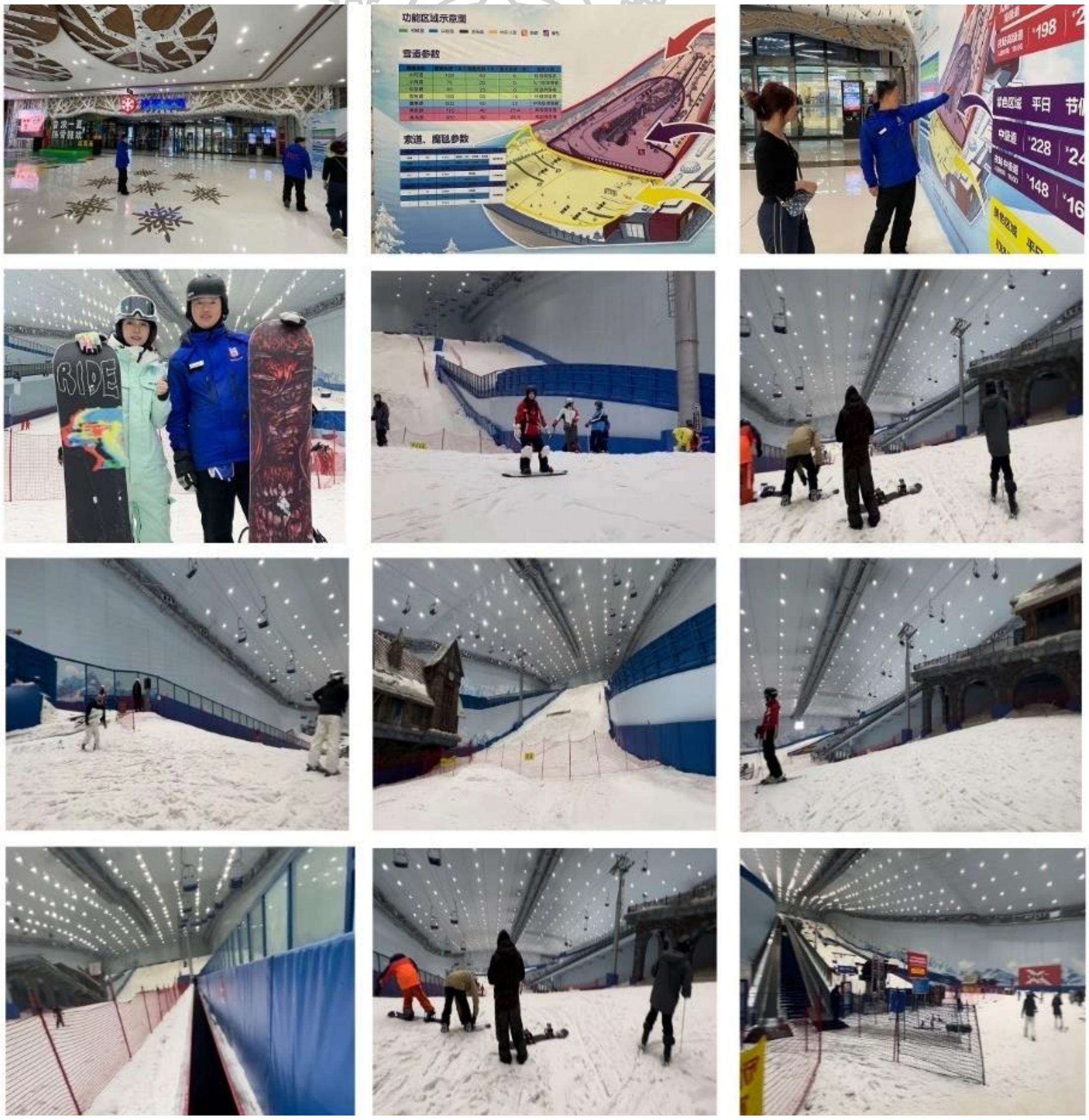
Source: Photo by the author

2) BONSKI Indoor Snow Theme Park

Located in Harbin, Heilongjiang Province, China, is a massive indoor snow theme park. The park covers approximately 369,600 square meters and includes advanced and intermediate snowboard slopes, a large indoor ice-skating rink, a movie technology park, and a children’s playground. BONSKI offers various winter sports facilities along with rich shopping and entertainment options, making it a comprehensive leisure destination (Figure 27).

Figure 27

Field Observation and Interview Processes at BONSKI Indoor Snow Theme Park



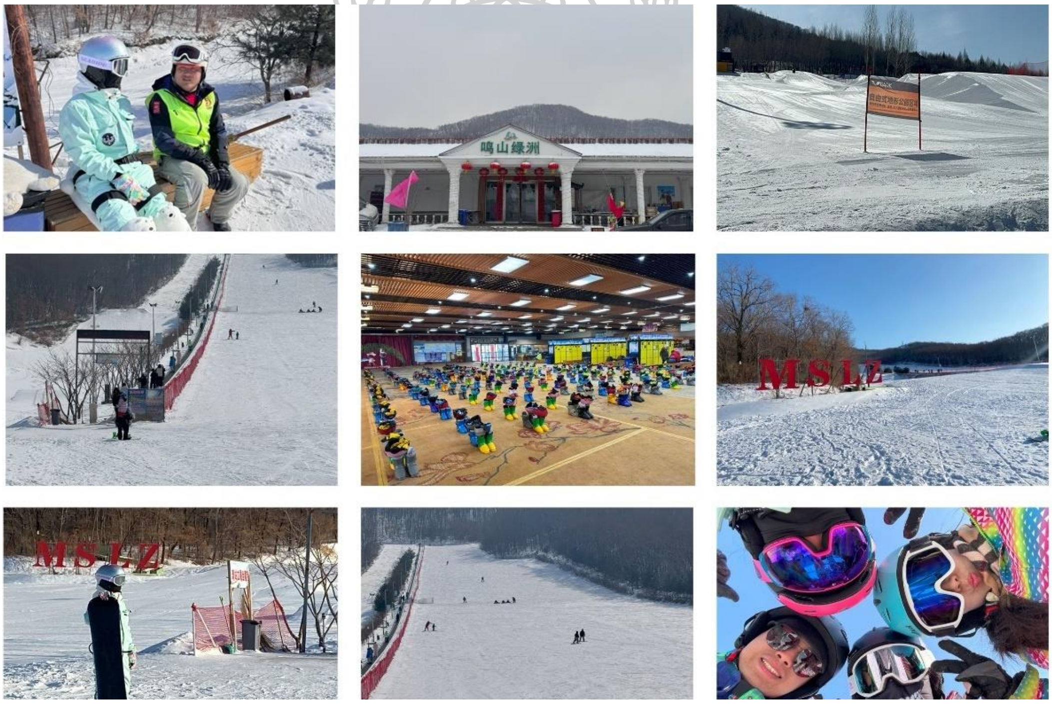
Source: Photo by the author

3) MSLZ Ski Resort

Located in Jilin Province, China, is a comprehensive medium- to large-scale ski resort emphasizing green ecological principles. The resort is well-equipped with advanced, intermediate, and beginner snow slopes and caters to snowboarders of all skill levels. Additionally, it offers winter activities, such as snow tubing, ice skating, and snowboarding parks. The primary customer groups included beginner and intermediate snowboarders, family tourists, and eco-tourism enthusiasts (Figure 28).

Figure 28

Field Observation and Interview Processes at MSLZ Ski Resort



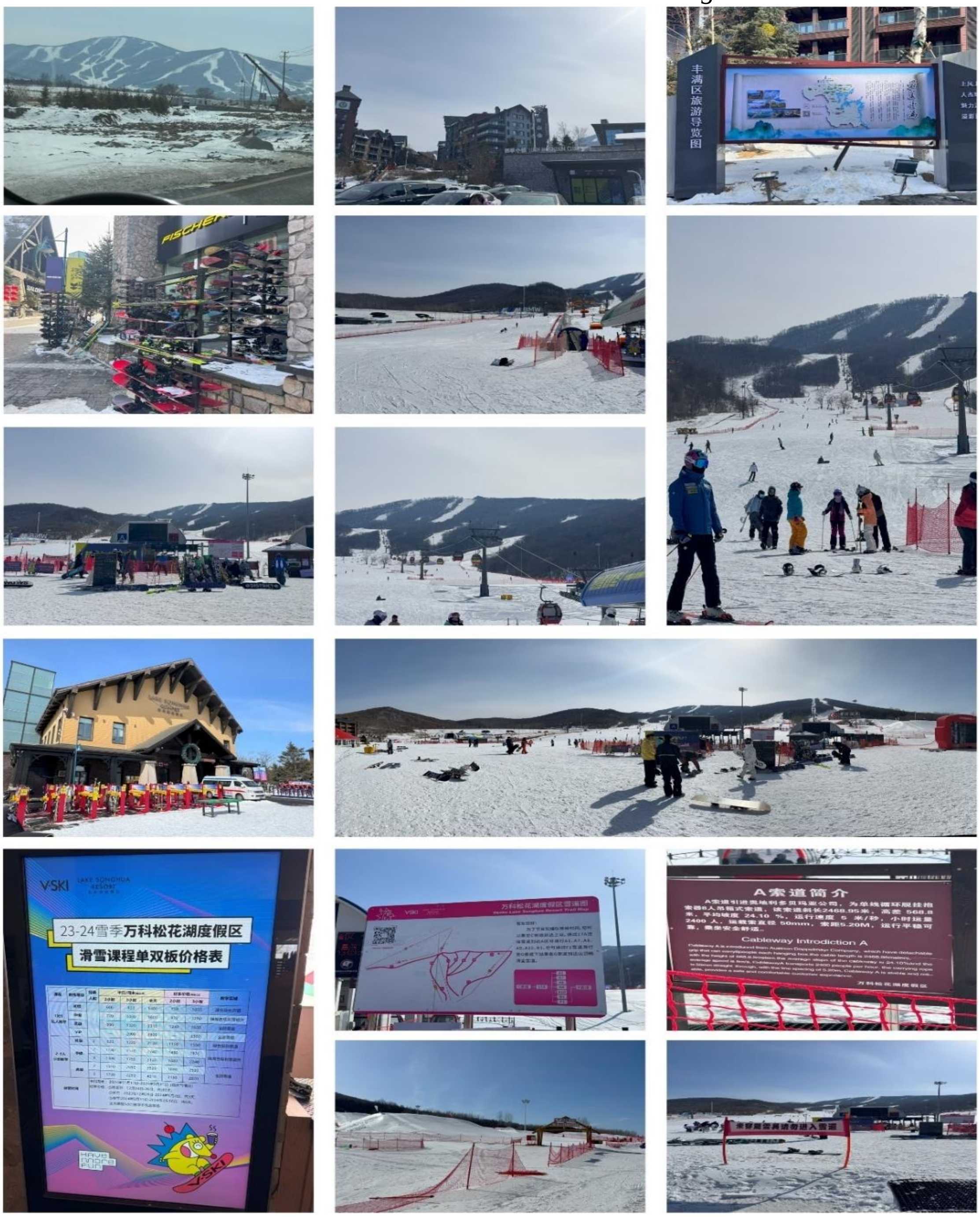
Source: Photo by the author

4) Vanke Lake Songhua Ski Resort

Located in Jilin Province, China, is a large, high-end ski resort that blends modern facilities with natural beauty. The resort boasts a wide range of amenities, including beginner, intermediate, and advanced snow slopes, catering to snowboarders of all skill levels. Additionally, it features a professional snowboard school, a children’s snow area, and family-friendly entertainment areas. The primary customer groups include snowboarders of all levels, family tourists, and domestic and international visitors. The resort's high-quality services and diverse activities make it an ideal destination for snowboarding, skiing, and winter vacations (Figure 29).

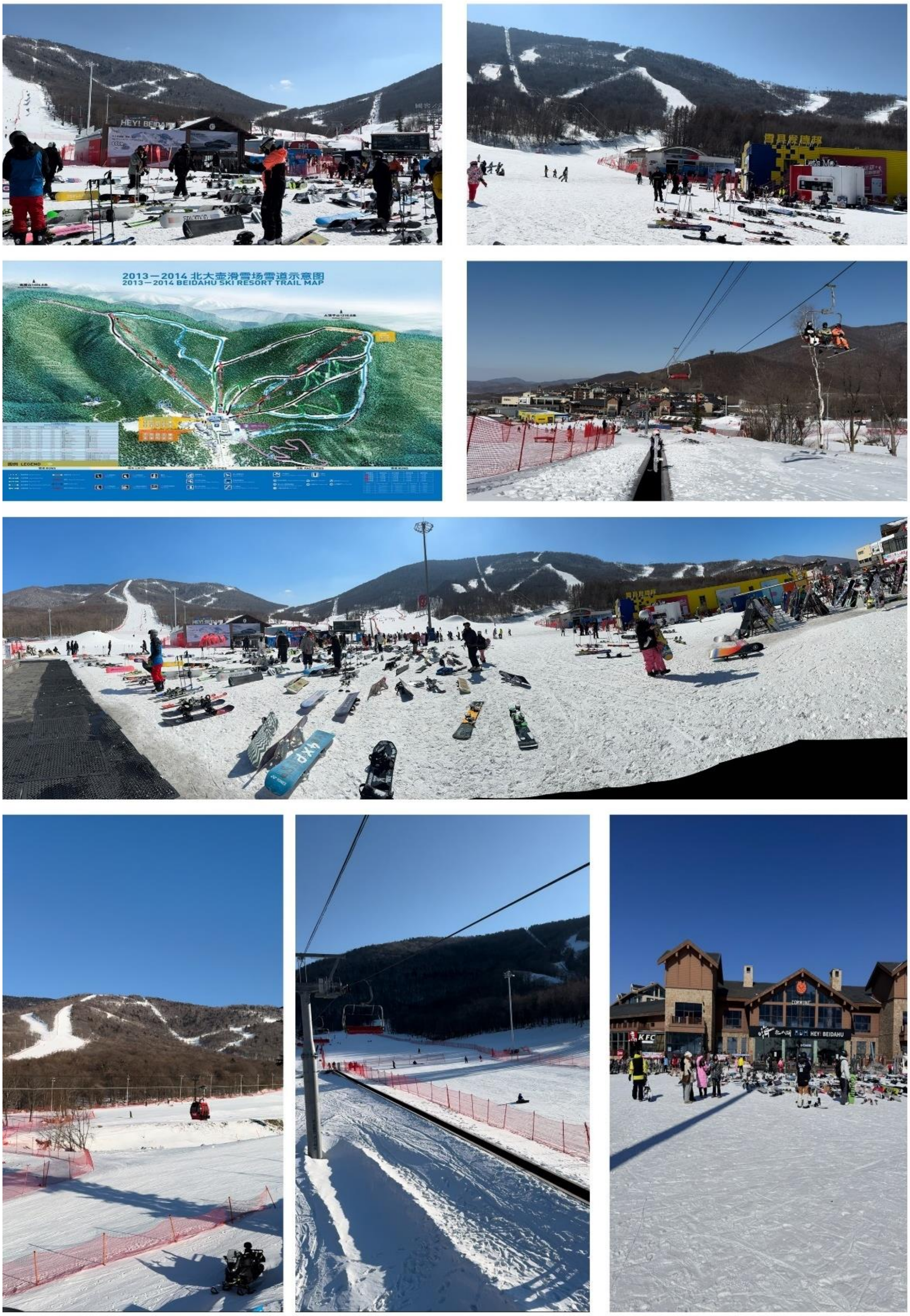
Figure 29

Field Observation and Interview Processes at Vanke Lake Songhua Ski Resort



Source: Photo by the author

Figure 30
Field Observation and Interview Processes at Beidahu Ski Resort



Source: Photo by the author

5) BEIDAHU Ski Resort

Located in Jilin City, Jilin Province, China, 53 km from the city center. It is a national AAAA-level scenic spot and a national snowboard tourism resort renowned as a “powder snow heaven.” The resort is in the world’s golden snowboard belt and boasts high-quality slopes, deep snow cover, and a long snow season. Currently, the resort features 64 snowboard runs totaling 72 kilometers, covering an area of 239 hectares. Equipped with 11 chairlifts and seven magic carpets, it is one of the largest ski resorts in Asia. The primary customer groups include intermediate and advanced snowboarders, professional athletes, snowboarding enthusiasts, and winter sports lovers. The resort’s high-quality services, diverse activities, and stunning natural scenery make it an ideal destination for snowboarding, skiing, and winter vacations (Figure 30).

4.3.1.1 FIELD OBSERVATIONS

During the field observations, the researchers discovered that beginners mainly comprised serious learners and one-time experienced players. Among the serious learners, there were long-term and short-term learners.

1) Learning Modes: A small minority of beginners, including long-term learners, short-term learners, and even experience-oriented players, are hired coaches. An even smaller proportion sought advice from high-level player friends, while most were self-taught.

2) Learning Outcomes: Beginners assisted by professional coaches exhibited more standardized movements. Despite varying basic skill levels, participants with coaching assistance acquired more skills than self-taught beginners.

3) Safety Issues: Beginners with professional coaches paid particular attention to safety measures and rarely fell or collided with other players on the slopes. Coaches provided immediate instructions regarding the appropriate protective stances

in hazardous situations. In contrast, self-taught beginners often lacked proper protective knowledge, resulting in frequent falls, injuries, and collisions.

4) Equipment Usage: Beginners assisted by professional coaches wore more appropriate and complete equipment. Those without coaching assistance often failed to wear appropriate equipment or did not use protective gear at all.

5) Emotional Aspects: Learners with professional coaching received timely encouragement and technical corrections when facing setbacks, boosting their confidence for future training. Self-taught players felt more frustrated and were likely to give up when encountering difficulties.

6) Social and Group Interactions: Researchers observed an interesting phenomenon: a significant number of high-level players approached the slopes alone, whereas almost all beginner players approached the slopes with companions. Subsequent interviews investigated this phenomenon further.

8) Adaptability to Environment and Facilities: The layout of the ski resort, the meaning of signs, and the accessibility of other facilities affected the players' experiences.

9) Economic Costs: This is a crucial aspect that influences learners' decisions. Players had to spend significantly at the ski resort, including but not limited to venue usage fees, essential equipment rental fees (snowboards, bindings, boots, snowsuits), protective equipment rental fees (helmets, knee pads, tailbone protectors, elbow pads), warm gear rental fees (warm socks, gloves, windproof masks, goggles), professional coach fees, and locker rental fees. Researchers observed that these costs were typically time-based. It is expensive to fully equip oneself. High-level players generally purchase equipment, often owning multiple brands and types. Thus, they only needed to pay the venue usage fee. Most beginners expressed surprise and hesitation when viewing the price list and rarely rented out all necessary items. They tended to only pay for essential items such as venue usage and basic equipment fees, often paying attention to protective and warm gear. However, these two conditions are

crucial for extreme snowboarding conditions. Researchers also found that most beginners, including experienced players, initially considered hiring professional coaches. However, many abandoned the idea due to high costs and the realization that more than one session was required for complete learning.

4.3.1.2 IN-DEPTH INTERVIEWS

In this phase, the researchers conducted in-depth discussions with players from different countries and regions, professional coaches, ski resort operators, and other personnel. They comprehensively and meticulously understood beginners' needs, preferences, and challenges.

1) Interviews with Players

Motivation

When researchers asked players why they preferred snowboarding, almost everyone said that it was excellent. The thrill of speeding down a snowy slope brings a sense of freedom to both the body and soul. Additionally, it is a good form of exercise and a way to make friends with similar interests.

Learning Costs

In in-depth interviews with the snowboarding players, the researchers found that experienced high-level players generally had substantial incomes that supported their snowboarding expenses. They also enjoy more flexible time schedules dedicated to learning snowboarding. They stated that in addition to having a passion for snowboarding, financial and time support were the most crucial factors for mastering snowboarding skills. The researchers confirmed this viewpoint during discussions with professional coaches and ski resort operators.

Additionally, researchers found that long-term learners mostly use their long vacations to learn snowboarding without worrying about high costs because their parents support them until they master the sport. Short-term learners are often working professionals with a passion for snowboarding who require more time and financial resources to devote to it. Short-term learning is insufficient for mastering the complete set of skills because snowboarding is a complex sport that requires long-term practice and reinforcement. The researchers also interviewed experience-oriented players, who are the primary traffic source for ski resorts. They expressed that the entry barrier for snowboarding is too high; as tourists, they want to invest only a little time and money into it during their trips. However, due to a lack of understanding of snowboarding, they often arrive with high hopes but leave disappointed.

Needs and Expectations

When asked about the needs of beginners, advanced players indicated that beginners often focus on how to get on the board and slide quickly, are eager for quick results, and neglect the practice of techniques and protective learning measures. Learning techniques are essential for advancing in snowboarding; if the basics are not solid, it will be challenging later on. Learning protective measures involves knowing how to protect oneself and others. Although falling is common in snowboarding, falls can easily lead to injuries or even death without proper protective equipment. Beginners also need to learn how to avoid other people on the slopes, which can cause trouble or harm to others. Researchers learned that beginners often do not use protective gear because they are unaware of its importance or potential dangers.

When asked about their expectations for educational experiences for beginner snowboarders, players expressed that the most anticipated feature would be the ability to learn without spending long hours at a ski resort. Experience-oriented players, in particular, said they do not need to master many techniques; simply being able to slide is sufficient. They want to spend only a little money on learning and prefer to arrange their time and place according to their schedule.

Views on Technology-Assisted Learning

In the study, the players expressed concern about cost-effective learning methods. Technology-assisted learning could provide a relatively economical option, especially outside the snow season or during non-holiday periods. Since many players have limited learning time, they prefer to use technological tools that quickly provide basic skill training. Therefore, simple, easy-to-use tools that do not require long-term commitment are preferred.

Moreover, when discussing existing technological methods, players clearly preferred virtual reality technology over familiar motion-sensing games on the market, such as those with motion-sensing cameras connected to large screens. They believed that VR technology could offer a more immersive learning experience, and their interactivity and entertainment value were more appealing to them.

2) Interviews with Ski Resort Operators and Managers

In conversations with ski resort operators and managers, the researchers learned that the high cost of snowboarding prevents many people from long-term participation in the sport. However, due to high maintenance costs and other expenses, they need to lower prices. Additionally, the number of highly qualified professional coaches is limited, resulting in the high cost of hiring coaches.

When asked about the number of injuries occurring daily at the resort, managers expressed anxiety. Despite the implementation of many warning signs, approximately one in ten people still get injured each day. Many people do not understand the importance of safety measures or how to correctly use facilities. Even though the resort includes personal safety insurance in the entrance fee for all visitors, they still hope that players will pay more attention to safety.

When discussing expectations for educational experience design for snowboarding beginners, the participants indicated that it would be beneficial if inexperienced enthusiasts, especially experienced-oriented players, could learn some basic theory and safety measures before coming to the resort; this could effectively reduce risks. Additionally, having some knowledge about snowboarding before hiring a coach could shorten the learning period and provide a better snowboarding experience in a shorter time.

Views on Technology-Assisted Learning:

Increasing Attraction and Competitive Advantage: Implementing new technologies, such as virtual reality, can enhance the resort's appeal to beginners and experience-oriented players, providing a unique competitive edge in the market. Offering advanced learning tools can attract more customers to high-tech learning methods.

Improving Learning Efficiency and Safety: Technology-assisted learning tools can help beginners quickly master basic skills while enhancing the safety of learning. Through simulated training, beginners can acquire the necessary skills and safety knowledge for downhill snowboarding.

Extending Learning Periods and Customer Loyalty: With technology-assisted learning, student and working professional players can continue learning and practicing even during the off-season, maintaining their interest in the resort and potentially increasing their revisit rates.

Optimizing Resources and Operational Efficiency: Applying new technologies can help resorts more effectively utilize resources. For example, VR learning systems can reduce the dependency on actual slopes and coaches, thereby lowering operational costs while offering more diverse services.

Market Feedback and Continuous Innovation: Introducing technology allows resorts to gather market feedback to improve their services quickly. For instance, based on customer feedback about VR learning experiences, resorts can adjust the instructional content and difficulty levels to meet customers' different needs at different levels.

The Platform for Education and Promotion: Resorts can utilize new technologies to become platforms for promoting snowboarding education and culture, extending beyond physical training to include spreading awareness of snowboarding culture and safety through technology.

3) Interviews with Snowboarding Instructors

During interviews with snowboarding instructors, the researchers found that snowboarding beginners often need additional help in understanding the principles of snowboarding before they begin learning. They merely believe that snowboarding is an excellent sport, and in the early stages of learning, beginners tend to be impatient and eager for quick results. Most students cannot maintain a long-term, stable learning cycle, leading to poor teaching effectiveness. The instructors also emphasized that learning to fall was more important than learning to slide. People often fall incorrectly, resulting in serious injuries or injury to others. This affects the players' snowboarding experience and wastes time. Experience-oriented players, in particular, often stop taking photos on the slopes or do not leave the center of the slope immediately after falling, causing collisions with players coming down behind them, which is very dangerous.

When asked about their expectations for educational experience design for snowboarding beginners, snowboarding instructors expressed that it would be beneficial for learners to preview the principles of snowboarding or have relevant sports experience beforehand. They also need to understand the proper use of equipment, the importance of protective gear, and how to protect themselves. This way, hiring an instructor can save time, allowing the instructor to focus on helping students improve their skills rather than other aspects of their learning.

Views on Technology-Assisted Learning:

Snowboarding instructors are both excited and cautious about introducing new technology into snowboarding learning. They see new technology as a valuable auxiliary tool but also recognize the importance of maintaining traditional teaching methods and the challenges involved. By integrating new technology, they hope to enhance teaching effectiveness and learning experiences while preserving the essence of traditional instruction.

Instructors believe that new technologies, such as virtual reality, can serve as auxiliary tools to help beginners learn basic skills in a safe environment while reducing the risks associated with actual slopes. New technologies can provide more personalized teaching methods. For example, data analysis and feedback mechanisms can help instructors better understand students' progress and areas for improvement.

Some instructors worry that introducing technology might diminish the value of traditional teaching methods or cause students to rely too heavily on technology, neglecting the experience and feeling of snowboarding. For instructors, the introduction of new technology also means that they must continuously update their skills and knowledge to use these tools effectively in teaching. New technology might increase students' motivation to learn, especially among the younger generation, who are more interested in high-tech products, thus making learning more engaging and attractive.

Some instructors are concerned that excessive use of technology could lead students to overlook the basic principles and safety practices of snowboarding. Additionally, some instructors mentioned that they might need to adapt to market demands for technology-assisted learning, potentially shifting their role from traditional instructors to a combination of technical and sports skill coaches.

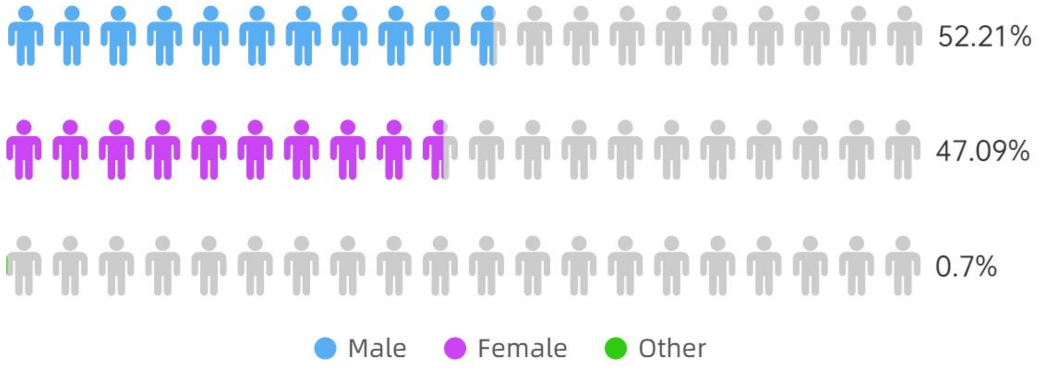
4.3.2 DATA ANALYSIS OF THE SECOND PHASE

The researchers developed a detailed online questionnaire based on the preliminary survey results to collect more extensive and detailed information. The researchers distributed 500 online questionnaires to online snowboarding enthusiasts. The questionnaire included a screening function to ensure validity; respondents needed to indicate their interest in snowboarding before proceeding. Ultimately, 429 valid responses were obtained. The results are as follows. The questionnaire consisted of three parts:

PART 1

The first section contains general information about the respondents (Figures 31 to 35).

Figure 31
Respondents' Gender Information



Source: Compiled by the author

Figure 32
Respondents' Age Information

Source: Compiled by the author

Figure 33

Respondents' Occupation Information

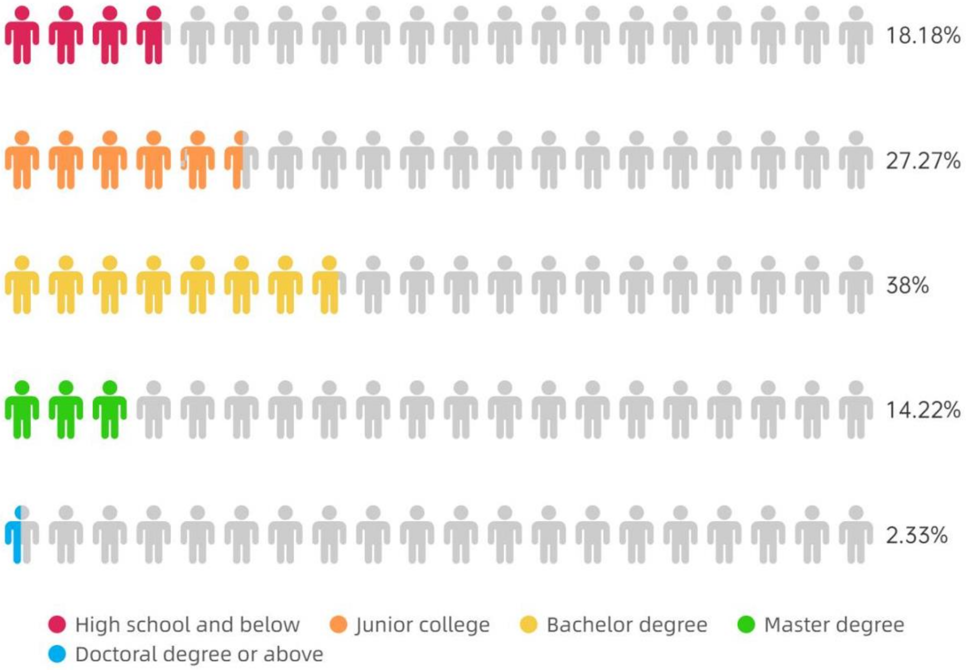
Source: Compiled by the author

Figure 34

Respondents' Income Range Information

Source: Compiled by the author

Figure 35
Respondents' Education Level Information



Source: Compiled by the author

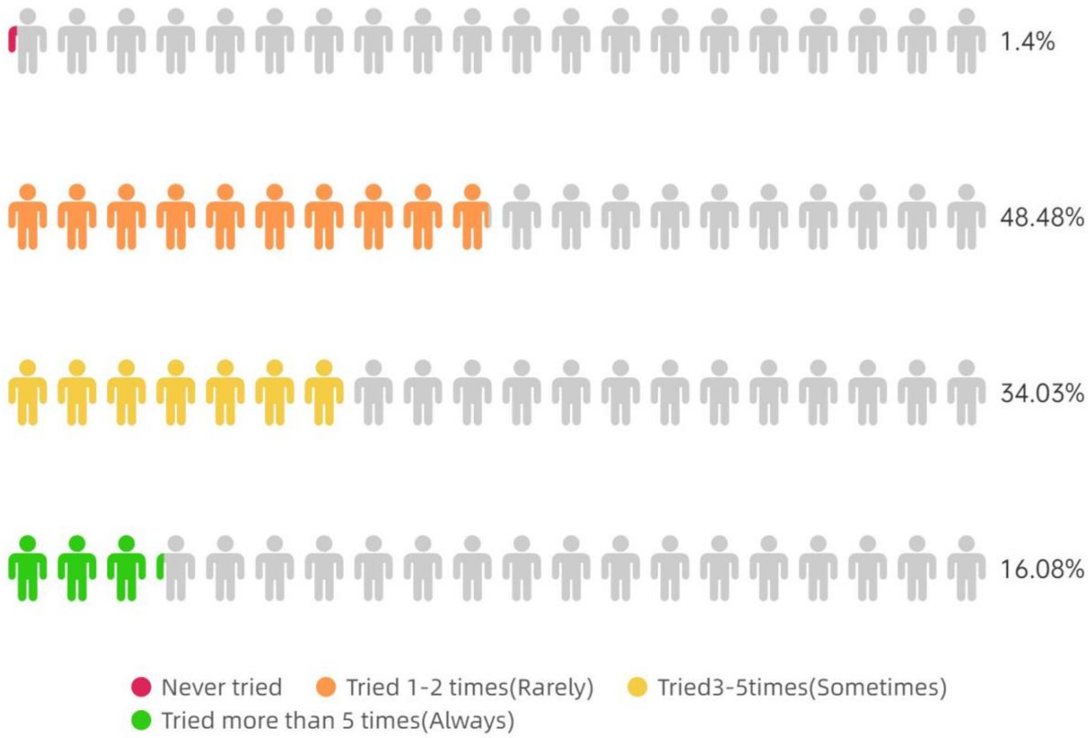
The results analysis revealed that although snowboarding has historically attracted more male enthusiasts, recent data suggests a growing number of female participants, leading to nearly equal participation rates among genders. The 18–40 age group dominated the enthusiast base, accounting for 85% of participants, indicating that snowboarding is especially popular among young and middle-aged individuals. The enthusiasts came from various professional backgrounds, including students, employees, and freelancers, showing that snowboarding appeals to people in different occupational sectors. Most enthusiasts reported an annual income between $0 and $30,000, suggesting a lower disposable income among the group. Additionally, a significant proportion of the enthusiasts held a bachelor's degree, indicating a generally higher education level within this community.

PART 2

This part of the survey specifically explored the motivations, preferences, and challenges snowboarding beginners face.

Figure 36

The Frequency of Respondents Attempting Snowboarding

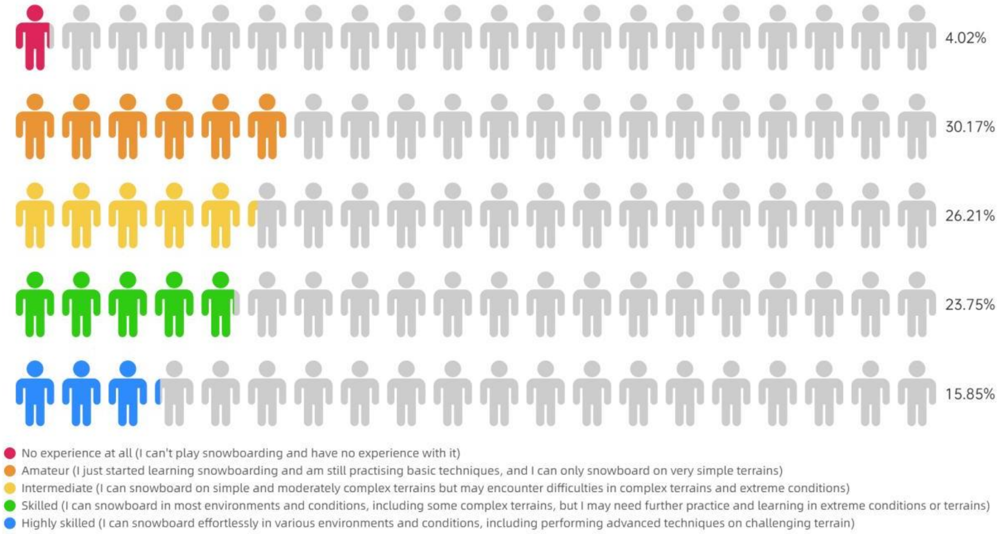


Source: Compiled by the author

The vast majority of respondents have tried snowboarding, with only 1.4% having never. However, as previously mentioned, the sample audience consists of individuals interested in snowboarding, including those who have not experienced it but are still interested (Figure 36). A total of 81.11% of respondents have tried snowboarding 1–5 times. According to snowboarding instructors, these individuals are typically classified as beginners. Therefore, the sample's perspectives can represent issues and challenges faced by snowboarding beginners.

Figure 37

Respondents' Self-Assessment Snowboarding Abilities



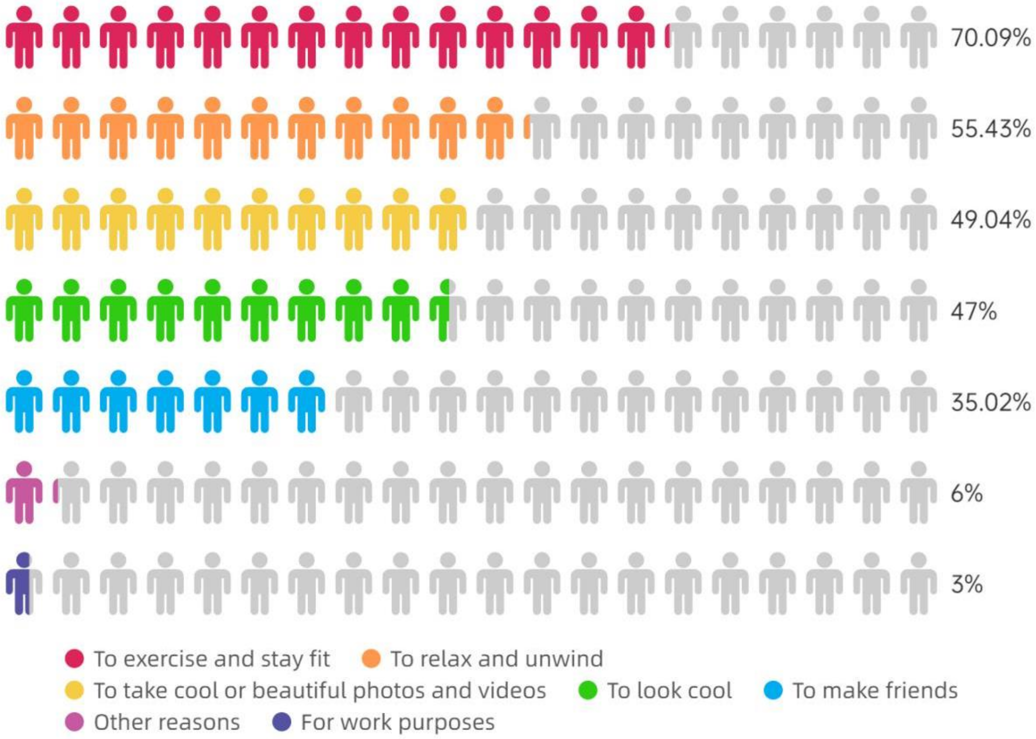
Source: Compiled by the author

The researchers designed the survey using a Likert scale, categorizing respondents' self-assessments of their snowboarding abilities into five levels. From the final results, it can be seen that among the 429 respondents, the vast majority needed more experience. Snowboarding instructors defined them as snowboarding beginners (Figure 37).

The researchers used a literature review, expert interviews, and field research methods to summarize six fixed-answer choices and one open-ended question (6+1) about why people are interested in snowboarding. This question was a multiple-choice question. Based on the given data, the researchers analyzed the reasons why respondents were interested in snowboarding (Figure 38):

Figure 38

Reasons for Respondents' Interests in Snowboarding



Source: Compiled by the author

The survey analysis revealed that snowboarding was a multifaceted activity that encompassed various personal interests and needs. A significant portion of respondents (55.43%) participated in snowboarding for relaxation, appreciating its stress-relieving benefits. Furthermore, 70.09% of participants considered it an effective form of physical exercise, underlining its health benefits. Social interactions were also a key aspect, with 35.02% of the snowboarders engaging in the sport for the opportunity to make new friends, indicating the sport's role as a social platform. The sport's cool factor was recognized by 47% of the respondents, highlighting the cultural appeal of snowboarding. 49.04% of those surveyed valued the creative opportunities it presented for photography and video, which connected snowboarding to visual arts. These findings suggest that snowboarding serves multiple functions, from leisure activity and exercise to a social gathering point and a medium for creative expression.

Figure 39

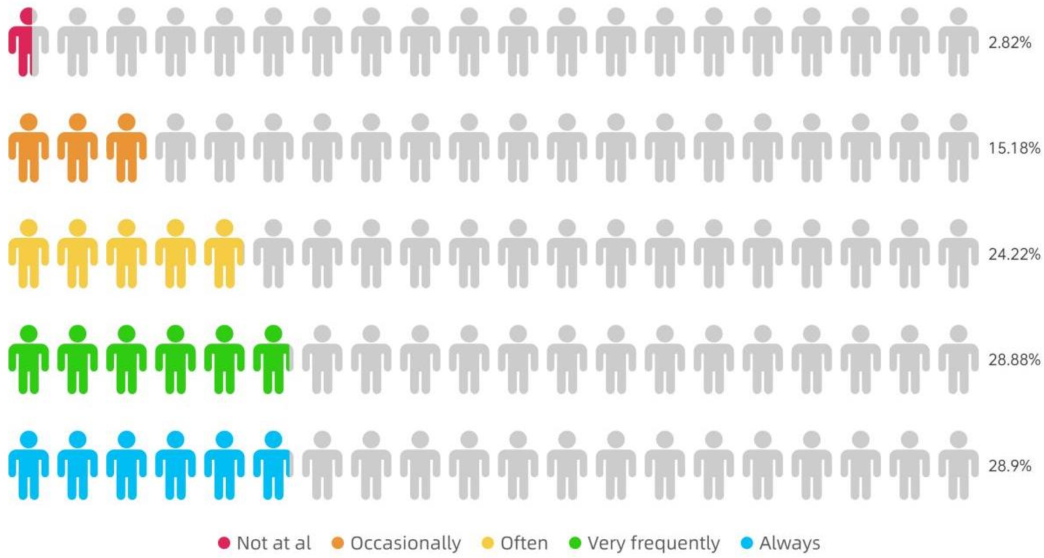
Reasons for Negative Factors Affecting Respondents' Participation in Snowboarding

Source: Compiled by the author

Based on the collected data, the researchers concluded that several factors influenced the infrequent participation in snowboarding (Figure 39). Geographical limitations were significant, with 42% of respondents living in areas without snow, which restricted their ability to participate regularly. Economic factors also played a critical role, as high costs associated with equipment and hiring instructors were prohibitive for many respondents; 53% found equipment costs too high, while 69% considered instructor fees too expensive. Time constraints further compounded the issue, with 50% of respondents indicating that work, school, other responsibilities, and the need to travel to snowy regions limited their ability to engage in snowboarding. Safety concerns were also prevalent, with 68% of respondents citing a fear of falling and injury as deterrents. Additionally, 35% mentioned that social pressure within their circles influenced their decision not to participate, indicating that negative social attitudes toward snowboarding affected their participation. These findings suggest that addressing geographical, economic, time, safety, and social factors is essential for increasing the popularity of snowboarding.

Figure 40

Psychological Stress Experienced by Respondents When First Trying Snowboarding



Source: Compiled by the author

The researchers designed the survey using a Likert scale to gauge the initial psychological experiences of the respondents when they first attempted snowboarding (Figure 40). The findings indicated that the vast majority (97.18%) experienced varying degrees of anxiety, likely due to unfamiliarity with the sport, fear of injury, or self-awareness of their lack of skills. Conversely, only 2.82% of respondents reported feeling no anxiety, suggesting that a small minority may possess greater psychological resilience, related experience, or higher confidence. This significant prevalence of anxiety underscores the importance of providing robust training and educational programs for beginners to help them overcome their fears and adapt to the sport more effectively. Additionally, the role of social support was highlighted as crucial, with psychological research showing the notion that trying new activities with friends and family can lower anxiety levels. Thus, promoting group participation or learning with friends could be a beneficial strategy for mitigating anxiety among new snowboarders.

Figure 41

Respondents' Specific Concerns Causing Emotions When First Trying Snowboarding

Source: Compiled by the author

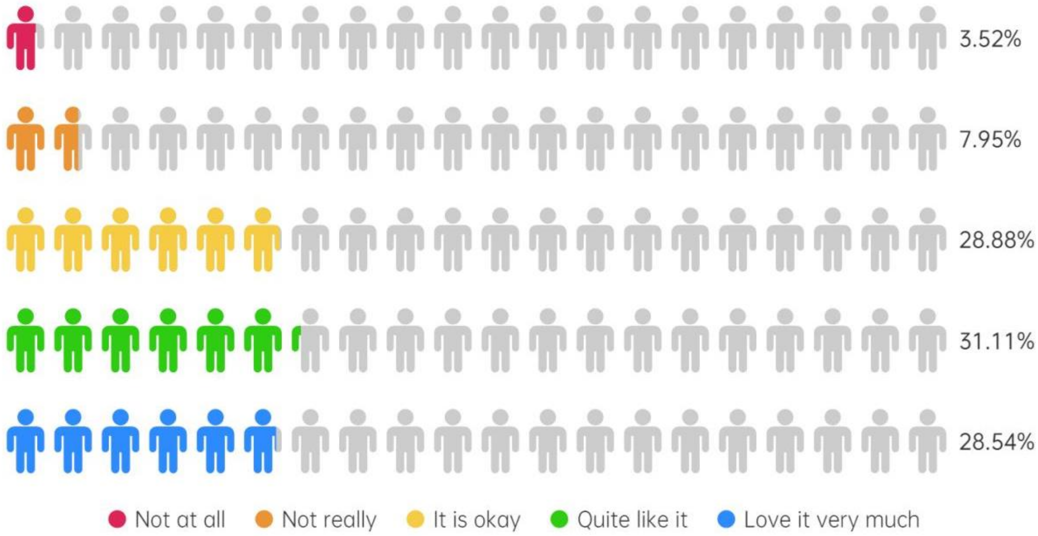
A significant 64.37% of respondents expressed fears about falling or getting injured, a common concern for beginners given the high-risk nature of snowboarding. A total of 60.14% of participants were worried about collisions with other snowboarders or skiers, highlighting uncertainties about navigating crowded ski resort environments and the behavior of other, possibly more experienced, participants. A total of 64.1% of the respondents did not hire a snowboarding instructor, mainly deterred by high costs. This left them attempting to learn independently without expert guidance, thus increasing their anxiety and uncertainty about appropriate techniques and safety. Time was also a significant concern for 54.55% of the respondents, who worried about the time commitment required to learn snowboarding adequately and its potential impact on other daily activities. This information highlights the needs of respondents (Figure 41).

PART 3

Learning and technical preferences of snowboarding beginner issue.

Figure 42

Respondents' Preferences for New Technology Integration Versus Traditional Teaching Methods

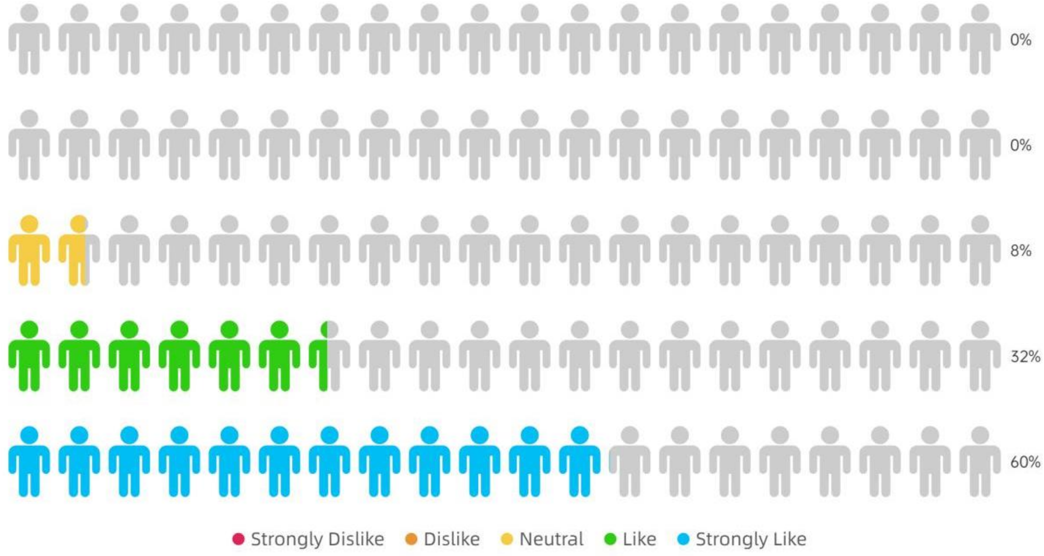


Source: Compiled by the author

The researchers utilized a Likert scale to evaluate the responses, categorizing them into five levels (Figure 42). The analysis revealed that new learning technologies were generally rated more positively than traditional teaching methods, with over half of the respondents demonstrating high levels of acceptance. This suggests that new learning technologies have considerable potential to enhance learning experiences and outcomes. However, further efforts to promote and optimize these technologies are required to increase user acceptance and satisfaction with neutral or opposing views. These findings offer critical insights for the future improvement and promotion of educational technologies.

Figure 43

Respondents' Preferences for Using New Technology to Learn Snowboarding



Source: Compiled by the author

The survey revealed that nearly all respondents expressed a favorable attitude toward using new technologies for learning snowboarding, with most choosing either "like" or "like very much." This high acceptance level indicates a strong interest and positive attitude toward adopting new technologies in snowboard instruction. The findings suggest that respondents generally have a strong affinity for technology, particularly younger individuals and tech enthusiasts who typically exhibit higher acceptance of new technologies. This positive reception highlights the demand for more effective and interactive learning methods, such as virtual, augmented, and mobile applications, which are perceived to enhance learning efficiency and experience (Figure 43).

The enthusiasm for new technologies also reflects their innovative appeal, which is a significant factor in their attractiveness. The strong preference suggests substantial market opportunities for introducing new technologies to snowboarding education. Despite these positive attitudes, further research is necessary to explore specific types of technology, methods of use, and various aspects of user experience to better understand and satisfy user needs. These insights provide valuable feedback for the future development and promotion of educational technologies in snowboarding instruction.

Figure 44

Respondents' Preferred Forms of Contemporary Technology-Based Learning

Source: Compiled by the author

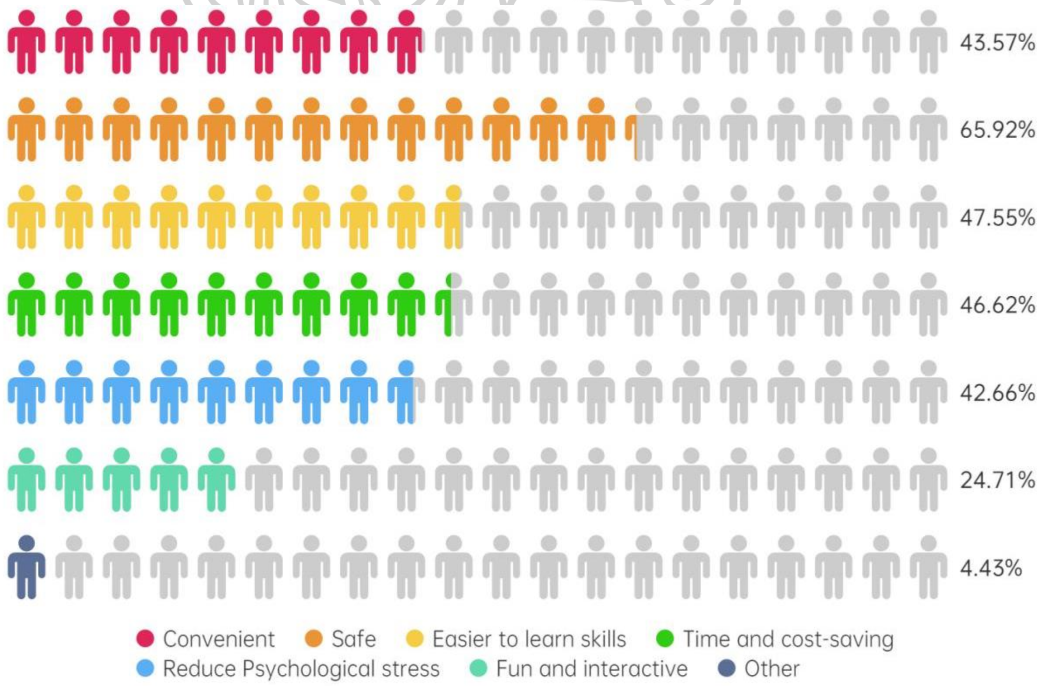
Users prefer virtual reality (VR) and mixed reality (MR) technologies in contemporary market-based learning methods primarily because these technologies offer highly immersive and interactive learning experiences. Augmented reality (AR) technology is also popular for convenience and practicality (Figure 44). The lower preference for distance education and online courses indicates that users have higher expectations for immersion and interactivity. Understanding these preferences can better guide future educational technology development and application strategies.

The survey results highlighted several vital advantages of virtual technology in snowboard education (Figure 45). The highest-rated benefit, chosen by 65.92% of respondents, was safety, emphasizing the significant appeal of a risk-free environment for practicing a potentially dangerous sport like snowboarding. Convenience and ease of learning were also noted, with 43.57% of respondents finding virtual technology convenient and 47.55% believing that VR technology makes learning skills easier.

This suggests that many participants appreciate the opportunity to learn and practice without having to travel to mountains or ski resorts. Moreover, 46.62% of respondents believed that VR technology could save time and costs. This indicates its potential as a cost-effective learning method by eliminating expenses such as entrance fees, equipment rentals, and instructor fees. The ability to reduce psychological stress was another critical factor, with 42.66% of respondents noting that simulated practice in a VR environment helps beginners build confidence by alleviating fears of falling, collisions, or other risks. In addition, 24.71% of respondents found VR technology fun and interactive, highlighting its entertainment value in addition to educational benefits. A small percentage, 4.43%, chose other factors, indicating that there are additional benefits not covered by the survey options but are still considered valuable by users. These findings underscore the multifaceted advantages of virtual technology in enhancing snowboard education.

Figure 45

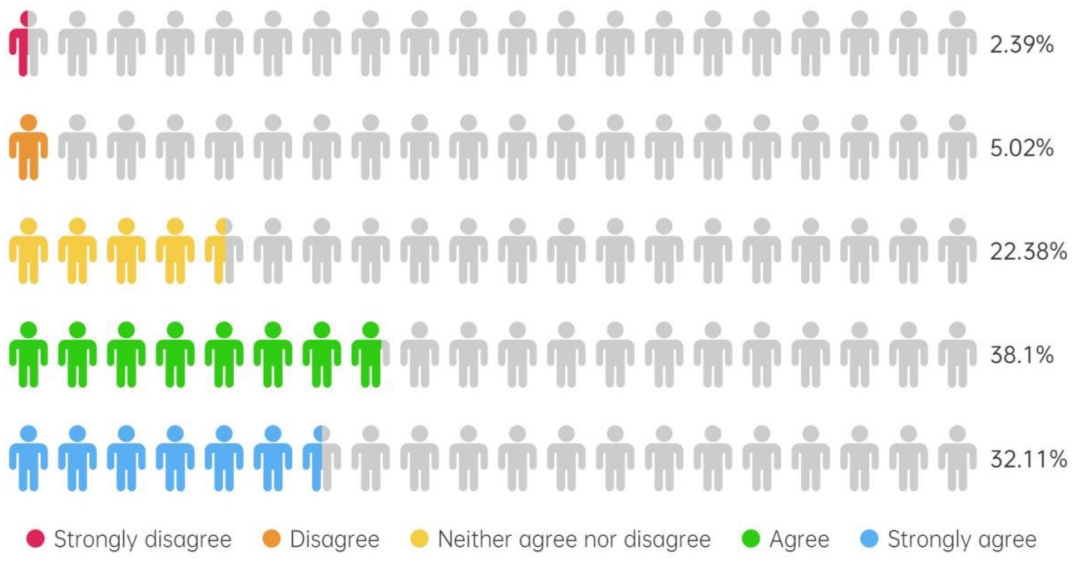
Preferred Forms of Contemporary Technology-Based Learning Among Respondents



Source: Compiled by the author

Figure 46

Respondents' Opinions on Whether New Technology Can Enhance the Educational Experience of Learning Snowboarding



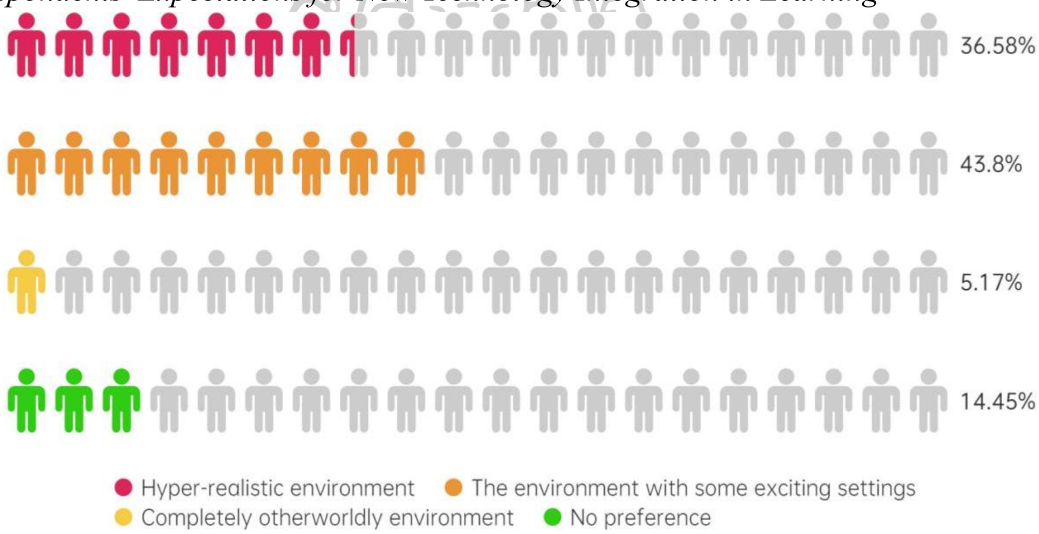
Source: Compiled by the author

The researchers analyzed the data from this question and drew the following conclusions (Figure 46). Compared to traditional learning methods, 70.21% of respondents supported the use of new technology in snowboard instruction. This indicates that most people believe that integrating new technology into learning has the potential to positively impact snowboard education. From an academic perspective, this aligns with the trend in modern educational technology research, where technology is seen as a tool to enhance and optimize traditional teaching methods, especially in fields that require highly visual and simulated experiences.

The researchers analyzed the data and proposed four virtual snowboarding environment designs for the respondents (Figure 47). The analysis revealed that 36.58% of participants preferred a hyper-realistic environment, indicating a significant preference among beginners for an experience that closely mimics the real world. This preference suggests that a realistic virtual environment can help beginners better understand and anticipate the sensations of snowboarding, facilitate skill transfer to real-world snowboarding, and reduce anxiety and fear by familiarizing themselves with the experience in a simulation. A total of 43.8% of participants favored an environment with some thrilling settings, highlighting a desire among some, especially those with prior snowboarding experience, for an experience that combines realism with entertainment elements. In contrast, only 5.17% of participants preferred a completely otherworldly environment, whereas 14.45% had no specific preference. These findings underscore the overall appeal of hyper-realistic and slightly thrilling environments, reflecting respondents' desire for realistic and engaging virtual snowboarding experiences.

Figure 47

Respondents' Expectations for New Technology Integration in Learning



Source: Compiled by the author

4.3.3 DATA ANALYSIS OF THE THIRD PHASE: EXPERT INTERVIEW

Through in-depth interviews with education experts, new media art experts, and human-computer interaction experts, the researchers collected valuable opinions and suggestions on educational experience design for snowboarding beginners. These interview results provide solid support for the conclusions of this study.

Findings from Interviews with Education Experts:

Education experts generally believe that VR and augmented reality (AR) technologies have great educational potential, offering immersive learning experiences. VR technology excels at simulating natural snowboarding environments, helping beginners practice basic skills safely, and increasing confidence and technique during snowboarding. Experts emphasized the importance of interactivity and engagement and suggested using gamification to motivate learners. They also pointed out that personalized instruction is critical to improving learning outcomes and recommended the design of differentiated teaching content and activities based on learners' specific needs and skill levels. Education experts suggested establishing multi-level feedback mechanisms, including immediate feedback and periodic assessments, to help learners promptly understand their progress and shortcomings. They stressed that collecting learner feedback helps optimize teaching content and enhances learner engagement and satisfaction.

Findings from Interviews with New Media Art Experts:

New media art experts believe that visual effects and artistic design play crucial roles in enhancing the immersion and satisfaction of the learning experience. They suggested using rich visual elements and dynamic effects in a VR environment to attract learners' attention and maintain their interest. Experts emphasized the importance of a simple and intuitive user interface design and recommended user-friendly interfaces and straightforward navigation to improve user experience. They also suggested incorporating emotional design elements and using colors, sound effects, and animations to evoke emotional resonance in learners and enhance enjoyment and engagement during learning.

Findings from Interviews with Human-Computer Interaction Experts:

Human-computer interaction experts noted that intuitive and easy-to-use interaction designs can significantly improve learners' operational efficiency and experience in VR environments. They recommended adopting various interaction modes (such as gesture control and voice commands) to accommodate different learners' preferences and needs. Experts emphasized the importance of usability testing, suggesting multiple rounds of testing during the design and development processes to gather user feedback and optimize the design. They also pointed out that behavior analysis can provide deep insights into learners' operational habits and needs, further optimizing interaction design to improve learning outcomes and user experience. Experts discussed the adaptability of different learners to new technologies and suggested flexible adjustment of technology application strategies during implementation to better serve educational goals. They also recommended designing real-time feedback mechanisms to help learners receive timely feedback and guidance during the learning process, thereby enhancing learning efficiency.

Finally, the researchers asked experts to select the most suitable existing technology formats for this study. The results are as follows (Table 4):

Table 4

The Most Suitable Existing Technology Formats

	Augmented Reality (AR)	***Virtual Reality (VR)***	***Mixed Reality (MR)***	***Distance Learning and Online Courses***
Time Flexibility	○	○	○	-
Location Flexibility	○	○	○	-
Cost-Effectiveness	○	○	-	-
Novelty	-	○	○	-
Immersion	-	○	○	-
Interactivity	○	○	○	-
Interactivity	○	○	○	○
Safety	○	○	○	○

Note. '○' representative believes that it has this function. '-' representative does not believe that it has this function.

Source: Compiled by the author

Through expert interviews, the researchers gained multifaceted professional insights that provided critical support for designing and optimizing educational experiences for snowboarding beginners. Education experts emphasized the importance of interactivity, personalization, and multi-level feedback. New media art experts offer essential suggestions for visual and artistic design. Human-computer interaction experts identified best practices in user interaction design and technology usability. In the final technology selection, the experts unanimously agreed that VR technology was the most advantageous choice. Collectively, these interview results ensured that the designed educational framework was scientifically rigorous and capable of effectively enhancing learning outcomes and learning experiences. In this way, innovative and efficient solutions can be provided for the future of snowboarding education.

4.4 DESIGN RESEARCH MODEL

4.4.1 SPECIFIC CONTENT OF EDUCATIONAL EXPERIENCES

At this stage, the study completed the first step of the ADDIE Learning Model by analyzing user characteristics, needs, challenges, and preferences. The summary is as follows:

1) Characteristics of Target Users:

Age Range: 18–40

Education Level: bachelor's degree or higher

Income: Limited disposable income beyond daily expenses

Ideal Learning Method: Desire to quickly master basic skills

2) Prior Knowledge of Target Users:

Snowboarding Experience: Little to none.

Sports Background: Some users have experience in other sports, which may affect their learning speed and snowboarding skills.

Awareness of Snowboarding Safety: Low awareness of safety measures and risk management.

Knowledge of Snowboarding Equipment: Need more knowledgeable.

3) The Experience Needs of Target Users:

Flexible Learning Time: The ability to arrange learning according to their schedule.

Flexible Learning Location: The ability to learn without going to a ski resort, allowing for learning at home or other places without being constrained by external environments.

Affordable Learning Options: High costs are a barrier for many beginners, so they expect more economical learning options.

Beginner-Friendly Environment: Creating a learning environment that reduces anxiety and worries for beginners. An immersive experience that smoothly transitions to natural snowboard scenes later on.

Accessible Teaching Content: This component provides easy-to-understand guidance and teaching methods to help students quickly adapt to the basics of snowboarding.

Engaging Learning Methods: Integrating new technologies and formats to enhance the experience and gamify learning.

Preferred Artistic Style: Realistic environment simulation

Social Interaction: Social interaction is vital to the learning experience of snowboarding. It not only facilitates making friends but also provides opportunities for mutual practice. Learners can improve their skills in a supportive environment through mutual encouragement and collaboration. Social activities can extend beyond snow slopes, such as taking part in social or recreational activities together after practice.

4) The educational needs of target users

Cognitive Content:

Basic Skill Cognition:

Understanding and recognizing basic snowboarding techniques, emphasizing essential skills for beginners.

Equipment Cognition:

Understanding and recognizing the necessary equipment for snowboarding: types, functions, and proper use of equipment.

Safety Awareness:

Acknowledgments of the importance of safety measures, including awareness of potential risks and taking appropriate safety precautions.

Facility Recognition:

Understanding the various facilities at a snowboarding site, their purposes, and how to effectively use them.

4.4.2 SELECTION OF THE TECHNOLOGY CARRIER

Based on the preliminary data analysis results, the researchers ultimately selected VR technology as the technological carrier for this study. Not only did potential users prefer VR technology, but experts also unanimously agreed during interviews that VR was the most suitable choice. VR Technology in Modern Education and Training Has Significant Advantages:

Flexibility in Time and Location

VR technology offers learners significant time and location flexibility. VR learning environments can be accessed according to their schedules without being restricted by fixed times. Additionally, as long as VR equipment is available, users can learn from home, school, office, or any other location, overcoming geographical limitations through internet access to global educational resources and courses.

1) Gradual Popularization and Market Growth

In recent years, VR technology has become more widespread, with equipment prices decreasing and performance improving. This trend has significantly increased the number of users, with more educational institutions and companies adopting VR for teaching and training. Market research reports indicate rapid growth in the VR market driven by technological advancements and reduced production costs, suggesting a continued increase in VR device adoption in the coming years.

2) Educational Applications and Novelty

Many schools and universities incorporate VR technology into their curricula to enhance student learning experiences, particularly in STEM education. The novelty and advanced nature of VR technology can attract students' interest, increasing their motivation and engagement in learning.

3) Immersion and Interactivity

VR provides an all-encompassing visual and auditory experience, allowing users to be fully immersed in the learning environment, thus enhancing focus and concentration. Highly realistic virtual environments can simulate real-world scenarios, making learning more concrete and vivid, which is especially suitable for complex skill training. In addition, VR offers a highly interactive learning experience, allowing users to interact with the virtual environment through various controllers and gestures, thereby promoting active learning.

4) Ease of Use and Safety

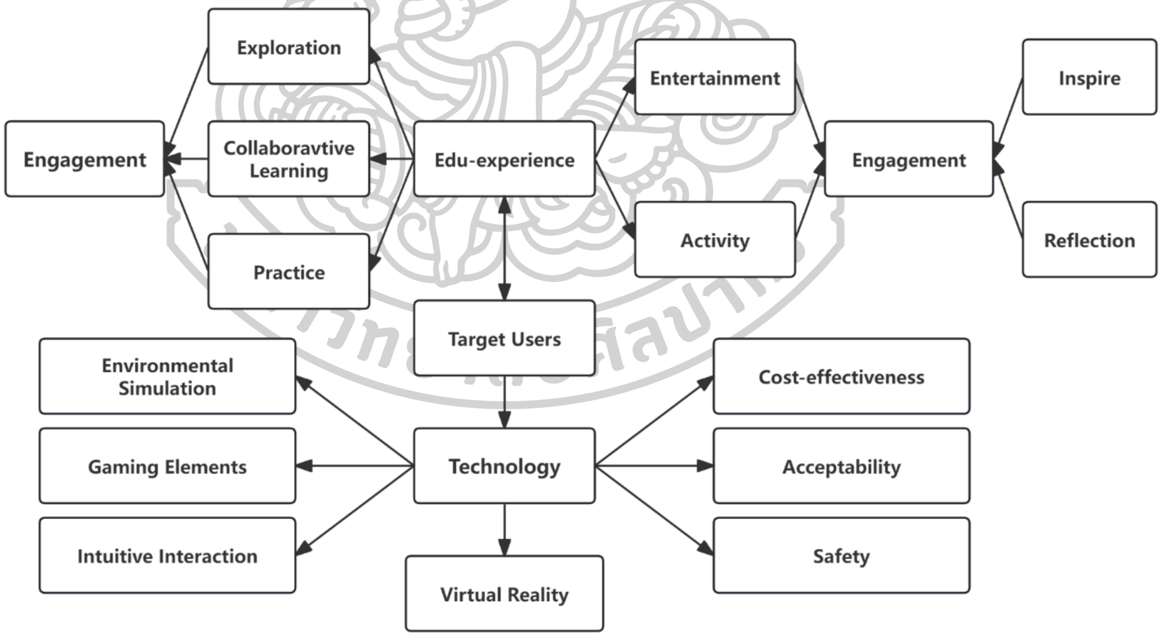
Modern VR devices and software increasingly focus on user experience, with simple and intuitive operation and a low learning curve. Users can quickly enter the virtual world for learning and exploration by wearing a headset and using controllers. VR provides a safe, simulated environment where users can train for dangerous or complex skills without real-life risks. For specific scenarios, such as public speaking training, VR can provide a psychologically safe environment to help users overcome nervousness and anxiety.

4.4.3 CREATING AN EDUCATIONAL EXPERIENCE DESIGN MODEL FOR SNOWBOARDING BEGINNERS USING VIRTUAL REALITY

The researchers developed a conceptual design model (Figure 48). The model is the design component of the proposed ADDIE Learning Model. The model applied Constructivist Learning Theory, affective design theory, and gamification concepts with a user-centered approach. The model emphasized the fusion between practical snowboarding skills and immersive digital experiences to provide beginners with a deeper engagement and holistic experience within a multidimensional educational framework. The proposed model bridged the gap between on-the-ground instruction and VR headsets, thereby helping snowboard beginners reduce learning costs and enhance their educational experience.

Figure 48

The Virtual Reality in Edu-Experience for Snowboarding Beginners Design Model



Source: Created by the author

Simulating real-world snowboarding environments in VR allowed users to learn and practice snowboarding skills through hands-on exercises in a safe environment. It provided users with opportunities to learn independently through exploration and experimentation. The proposed system includes designed inquiry-based tasks that allow users to discover the principles and best practices of snowboarding skills. Asked practical questions about snowboarding skills and allowed users to analyze and propose solutions. The designed activities to build online communities that encourage users to collaborate with others and share knowledge and experiences. This model encourages users to reflect on their learning processes and outcomes to promote deeper understanding and consider users' existing knowledge and experience when designing content.

This model also included designing a visually appealing and intuitively easy-to-use VR interface that attracts users through engaging graphics and colors. The design must use high-quality images, distinct sound effects, and realistic simulated environments to stimulate users' curiosity and interest. Ensured that the interaction design of VR applications was intuitive and fluid, which made it easy for users to understand how to operate in a virtual environment. Created learning activities relevant to users' interests and experiences, adding emotional depth to content through storytelling and simulations to enhance the learning experience. Enhanced immersion by assigning users specific roles in the virtual environment to enhance enjoyment. Exciting and fun lessons were provided to avoid the fatigue associated with learning programs.

4.5 CHAPTER SUMMARY

This chapter describes the research design process based on the ADDIE Model, focusing on critical aspects such as user characteristics analysis, needs assessment, and educational and experiential content design. The study identified users' age range, education level, economic status, and ideal learning methods through a comprehensive analysis of the target users. In addition, it analyzed users' prior knowledge and experience needs, including requirements for flexible learning times and locations, affordable learning options, beginner-friendly environments, and engaging learning methods.

The researchers utilized Constructivist Learning Theory, Emotional Design Theory, and gamification to ensure the effectiveness and appeal of the educational and experiential content. Specific elements included exploration and discovery, situational learning, interactive learning environments, positive emotional responses, rich interactive designs, customizable games, and personalized roles.

By integrating these theories and elements, this study aimed to create an immersive, highly interactive, and personalized learning environment to meet the learning needs and preferences of target users, ultimately improving learning outcomes and satisfaction. This chapter’s design laid the foundation for the subsequent development and implementation of the educational experience plan, ensuring that the entire teaching process effectively meets the needs and expectations of target users.

CHAPTER 5

DESIGN DEVELOPMENT AND TESTING

This chapter provides a detailed account of the research process design, development, and testing stages. First, the researchers presented various aspects of content design, including educational experience and art element design. Next, we described specific steps and methods of the development phase. Finally, we presented the testing process and results and analyzed their impact on achieving the research objectives.

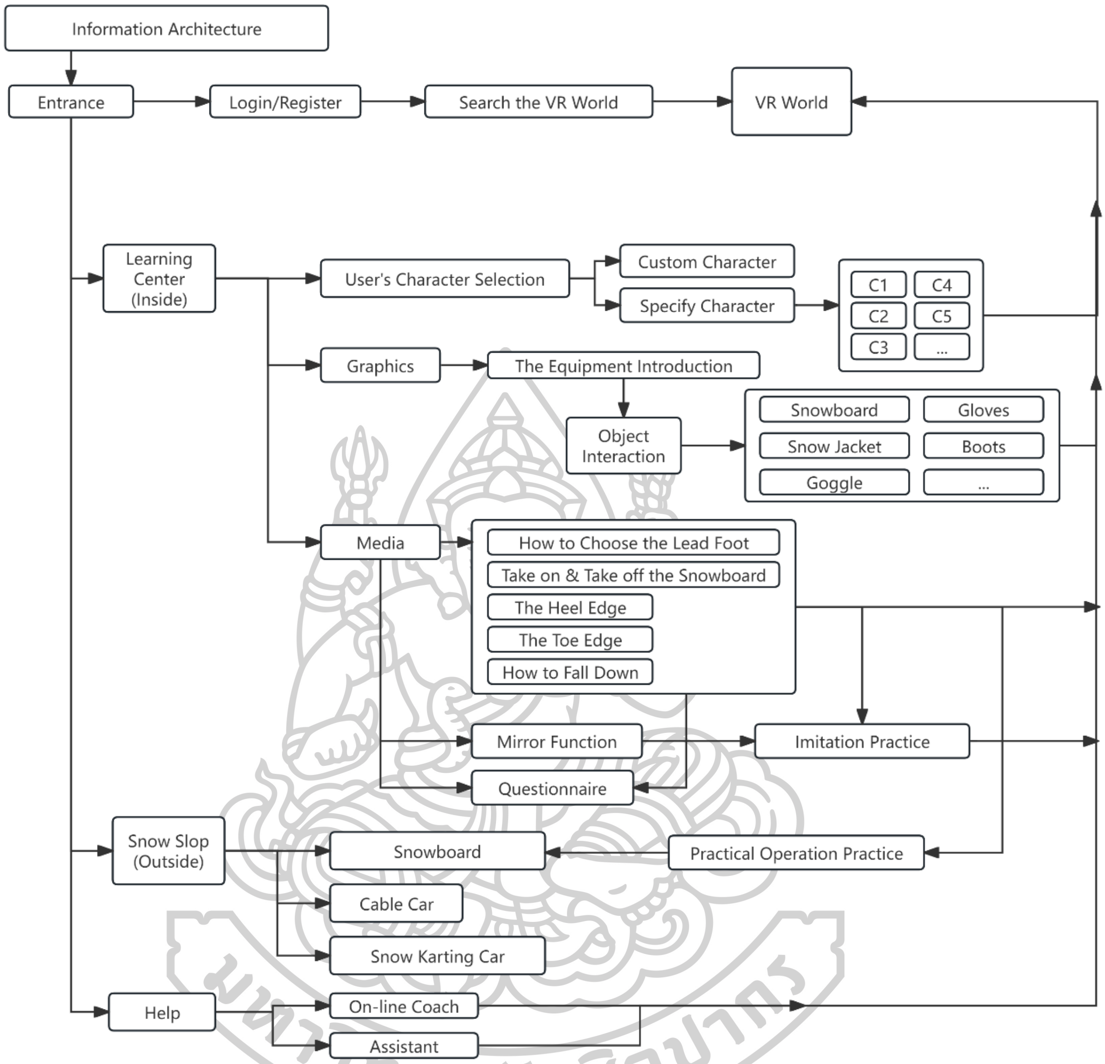
5.1 CONTENT DESIGN

5.1.1 INFORMATION ARCHITECTURE DESIGN

In the virtual world of the edu-experience for snowboarding beginners developed in this study, the information architecture has several main parts. The first step is the entry step, where the user must first register or log in. The second part is the learning center, where the user can learn the lesson by watching media or observing graphics. After learning, follow-along exercises, simulation exercises, and questionnaires were administered to review skills and knowledge. For snow slopes, users can use snowboarders for practical hands-on practice, lifts, and snow go-karts. Another section for help: Users can use this section to seek help from assistants or online coaches. The information architecture diagram for the overall design of the edu-experience for snowboarding beginners in VR is as follows (Figure 49):

Figure 49

The Information Architecture



Source: Created by the author

5.1.2 LEARNING CONTENT DESIGN

The researchers developed a teaching syllabus for snowboarding beginners based on the results of the data analysis. The teaching syllabus included some theoretical and some skill-learning sections. The complete content is as follows (Table 5):

Table 5

Teaching Syllabus for Snowboarding Beginners

Theory Learning	***Skill Learning***	
Safety Guidelines	Skill 1	Basic Stance and Body Posture
Introduction to Snowboarding Equipment	Skill 2	Choosing the Lead Foot
Emergency Measures and First Aid Knowledge	Skill 3: Heel Edge	Slope Pushing Braking Sliding Left and Braking Sliding Right and Braking Falling Leaf
Facility Recognition	Skill 4: Toe Edge	Slope Pushing Braking Sliding Left and Braking Sliding Right and Braking Falling Leaf
	Skill 5 Edge Switching	-

Source: Compiled by the author

Since the edu-experience of each learning content was multidimensional, the researchers compiled the edu-experience methods included in each learning content as follows (Table 6):

1) Modeling: Modeling utilizes video-based instruction, which comprises five modules. Each video lasts for one minute. The researchers recorded the videos with professional snowboarding instructors who taught skill training and theoretical learning. Learners can see the practical application of the required skills and understand the underlying principles.

2) Imitation Learning: The researchers set up interactive imitation sections and mirror functions within the scenario to make it easier for users to engage in physical learning. Learners practice the movements in the videos to master the basic techniques and necessary actions.

Table 6

Edu-experiential Dimensions of Learning Content

	Modeling Learning	***Imitation Learning***	***Interactive Learning***	***Exploratory Learning***	***Inquiry-Based Learning***	***Self-Directed Learning***
Safety Guidelines	○			○	○	○
Snowboarding Equipment	○	○	○	○	○	○
Emergency Measures First Aid Knowledge	○			○	○	○
Facility Recognition	○		○	○	○	○
Skill 1 Stance	○	○	○	○	○	○
Skill 2 Lead foot	○	○	○	○	○	○
Skill 3 Heel Edge	○	○	○	○	○	○
Skill 4 Toe Edge	○	○	○	○	○	○
Skill 5	○	○	○	○	○	○

Note: The table with '○' indicates that the course has the corresponding features.

Source: Compiled by the author

3) Interactive Learning: Students practice and test their skills through interaction with the program. In the virtual world, every function is realized through interaction, and it is designed to mirror real-world interactions. For example, they use snowboards, ride chairlifts, and make coffee. These functions are achieved using controllers or gesture trackers.

4) Exploratory Learning: Exploratory activities in a virtual world that simulate real-world conditions effectively transfer learned cognitive skills to real-world

activities. Students practiced snowboarding on different virtual terrains and conditions and observed and analyzed their performances to identify areas for improvement.

5) Inquiry-Based Learning: Through Q&A sessions, students explore and answer fundamental questions about snowboarding. This method stimulates curiosity and inquiry, enhancing students' understanding and application of snowboarding theory.

6) Self-Directed Learning: Students can choose their learning content and pace independently according to their interests and needs, thus enhancing autonomy and motivation.

7) Gamified Learning: By integrating game elements and activities into the learning process, users can choose their preferred roles or use the roles provided in the virtual world. This approach aims to increase fun and engagement in learning.

8) Social Interaction: Users are encouraged to engage in social activities at places like snow-karting tracks and resort cafes. Organizing group activities, competitions, and social games promotes user interaction and communication, thus boosting users' learning confidence.

9) Experiential Activities: Interactive segments such as photo ops and dancing allow users to relax and have fun during breaks, enhancing the resort's appeal and attractiveness. This approach provides users with enjoyable snowboarding experiences and enriches their memories of other activities.

These strategies enable the snowboarding resort to offer a rich educational experience while enhancing overall learning and entertainment through various social and interactive activities.

The researchers designed five sets of video learning content based on the instructional design and evaluated the methods (Table 7). The educational content videos consisted of six parts, with different lengths of study allocated according to the importance of the video learning content. Regarding controlling the snowboard, the learning duration was longer than the other conditions, and more easily learned content was learned. The learning modes were user-defined, allowing the user to choose which course to take, for how long, and how often, according to their schedule. These courses were tested in two ways: by the user in the system or by contacting an online coach.

Table 7

Video Learning Content Design

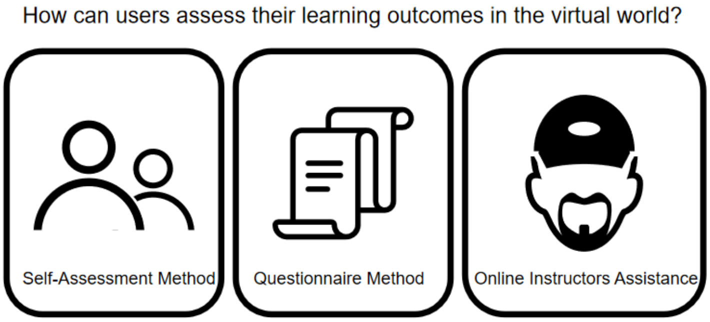
Education Content	***Duration***	***Study Frequency***	***Test Style***
Introduction of the Equipment	30s	User-defined	Self-assessment/Online Coach
How to choose the right person the Lead Foot	61s	User-defined	Self-assessment/Online Coach
Take on and take off the Snowboard	79s	User-defined	Self-assessment/Online Coach
The Heel Edge	132s	User-defined	Self-assessment/Online Coach
The Toe Edge	132s	User-defined	Self-assessment/Online Coach
How to Fall Down: A Short Introduction	70s	User-defined	Self-assessment/Online Coach

Source: Created by the author

5.1.3 LEARNING TEST DESIGN

In an educational experience of self-directed learning, how users measure the validity of their learning is a critical aspect. In this study, the researchers set up three self-assessment modes to satisfy user needs. The researchers designed the following evaluation methods (Figure 50).

Figure 50
User Test in the VR World



Source: Designed by the author

1) Self-Assessment Method

Given that this study emphasizes user autonomy, users can select learning durations and methods based on their conditions. After considering themselves successful in learning, they tested their skills using a virtual snowboard in the virtual world. Or they can invite friends to test each other.

2) Questionnaire

Users can assess their learning outcomes by answering questions provided in the virtual world. However, the drawback of this method is that it only tests users' theoretical knowledge. Users can combine this method with the snowboard test to obtain a more comprehensive assessment.

3) Online Coach Assistance

The virtual world provides a connection with online coaches. Professional snowboarding instructors can assess user learning outcomes without meeting users in person by conducting evaluations entirely in a virtual environment.

5.2 BRANDING DESIGN

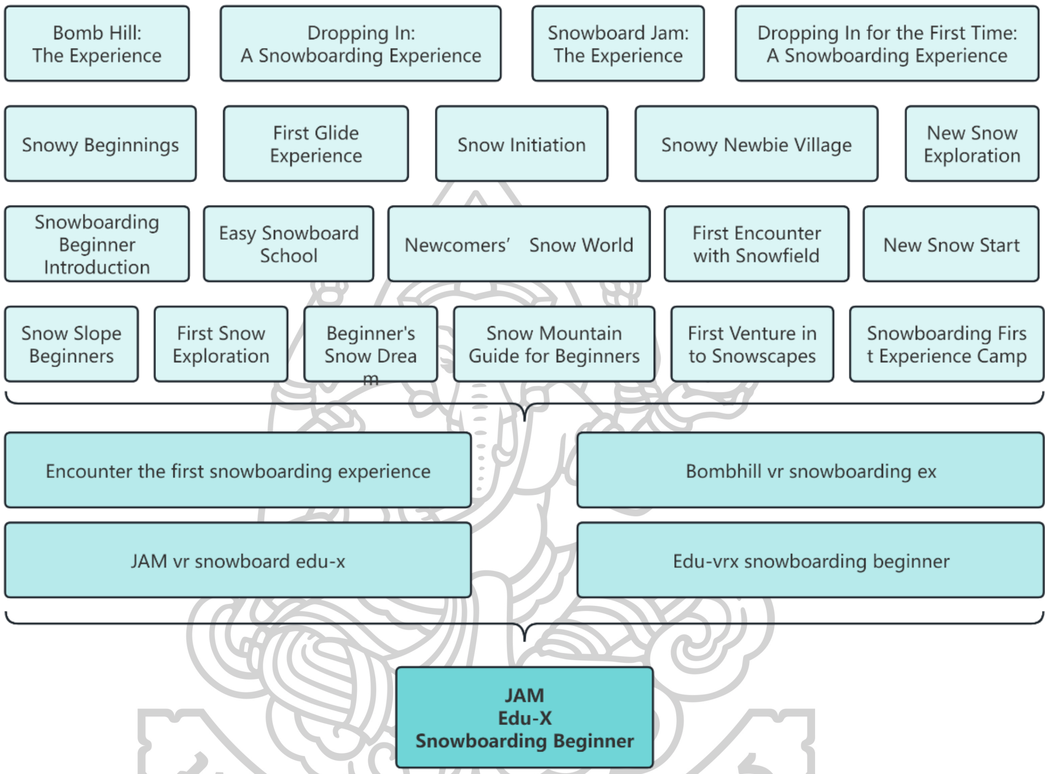
5.2.1 NAME OF BRANDING

The researchers designed 20 names for the project and discussed them with the expert panel. The experts designed four final names based on these names and the research content. The researchers then put these four names up for online vote.

Ultimately, “JAM Edu-X Snowboarding Beginner” received the most votes. The researchers will proceed with the design using this name（Figure 51）.

Figure 51

Select the Name of the Program



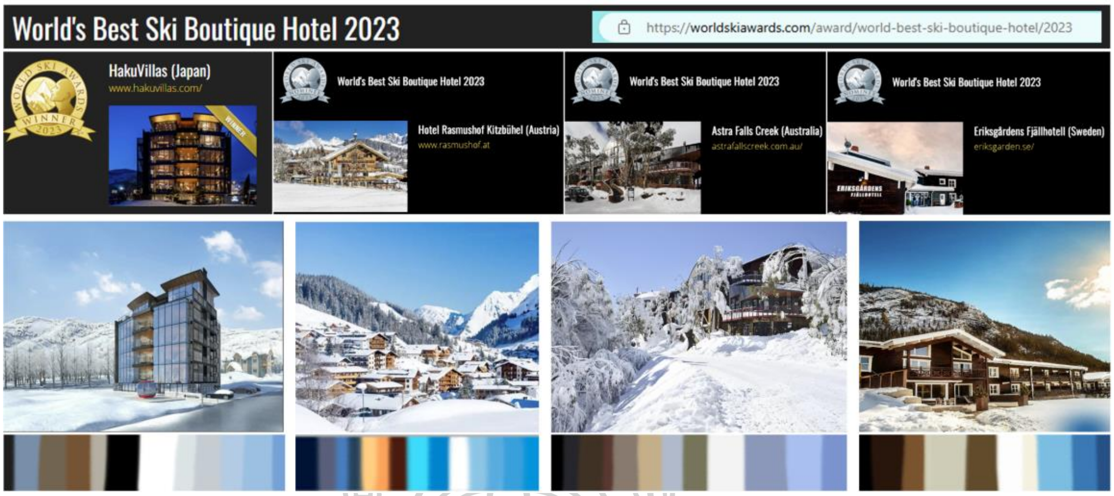
Source: Design by the author

5.2.2 COLOR SCHEME DESIGN

The researchers selected four photos of scenes from the world’s best ski boutique resorts selected for 2023 and used special software to extract the main color composition of each photo (Figure 52). We launched an online poll to select the most beautiful color scheme. The photo of Hotel Rasmushof Kitzbuhel received the most votes. The researchers chose this color scheme for all the next designs.

Figure 52

World's Best Ski Boutique Hotel in 2023



Note. Color palettes were created by the author.
Source: https://worldskiawards.com/award/woeld-best-ski-boutique-hotel/2023

5.2.3 LOGO DESIGN

1) Logo 1

Character Image: The VR headset and snowboarding goggles have a remarkably similar appearance. The researchers combined and modified these two elements to create a unique and modern logo. Including the three letters "JAM" adds a personalized touch to the logo, conveying the brand's name or concept. This design symbolizes the fusion of snowboarding and VR technology, reflecting the impact of modern technology on traditional sports. This design not only enhances the technological appeal of snowboarding but also conveys a futuristic visual message. This aligns with this study's "emotional design" concept, which aims to evoke emotional resonance and interest among users.

Colors and Graphics: The logo's primary colors are blue and orange. Blue symbolizes the atmosphere of ice, snow, and winter, conveying a sense of freshness and vitality. Orange adds warmth and energy. The combination of colors and the streamlined design enhances the dynamic visual effect, thus capturing user attention. This is consistent with the "visual" and "color" design strategies of this study, which aim to enhance the user experience through visual appeal.

Interactive and Gamification Elements: The logo's combination of a VR headset and snowboarding goggles reflects the integration of VR and the snowboarding experience. Using the letters "JAM" adds to the brand's interactivity and fun. This design stimulates users' curiosity and interest and encourages them to engage in snowboarding and VR activities, which aligns with this study's "gamification" and "interaction" strategies. Through this design, users can intuitively understand and experience the fun and innovation of combining snowboarding with VR (Figure 53).

Figure 53
Logo 1

Source: Designed by the author

2) Logo 2

This is another snowboarding-themed logo design. Here are the design sources for this study (Figure 54).

Character image: The logo shows a snowboarder wearing equipment, representing the vitality and dynamism of snowboarding. The image of a snowboarder is simple and vivid, conveying a professional and pleasant snowboarding experience. This is in line with the "emotional design" concept in this study, which aims to stimulate users' emotional resonance and interest.

Figure 54

Logo 2

Source: Designed by the author

Color and Graphics: The primary color is blue, which symbolizes the atmosphere of ice, snow, and winter while conveying a sense of freshness and vitality. The color gradient and streamlined design enhance the visual dynamics and attract users' attention, which is consistent with this study's "visual" and "color" design strategies.

Interactive and Gamification Elements: The dynamic design of a snowboarder sliding on snow reflects the speed and excitement of snowboarding and increases the logo's interactivity. This design can arouse users' curiosity and interest and encourage them to participate in snowboarding activities, which is consistent with the study's "gamification" and "interactive" strategies.

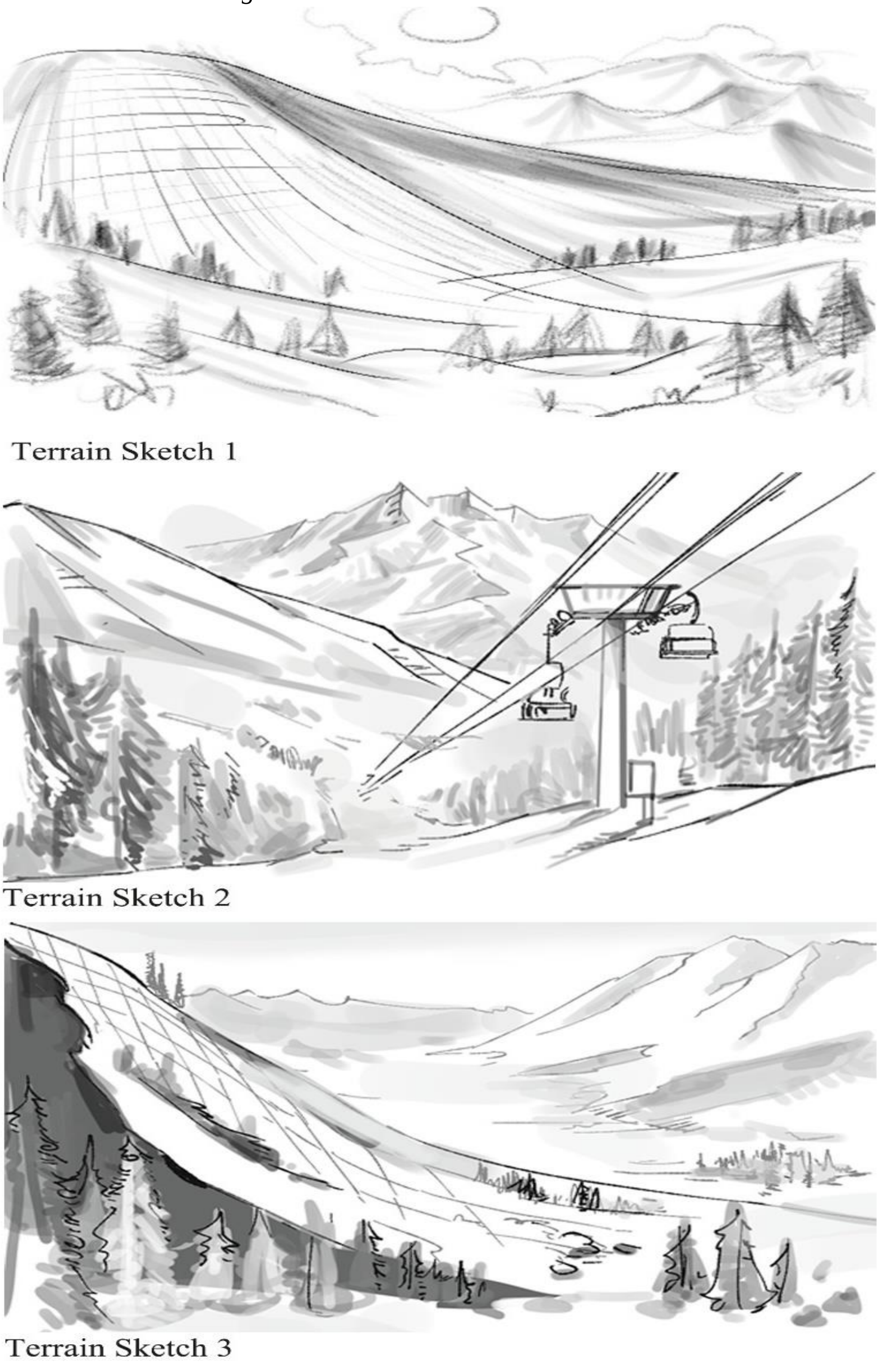
5.3 VISUAL DESIGN

5.3.1 TERRAIN DESIGN

After investigating a number of ski resorts, the researchers carried out a series of sketches (Figure 55).

Figure 55

The Terrain Sketch Design

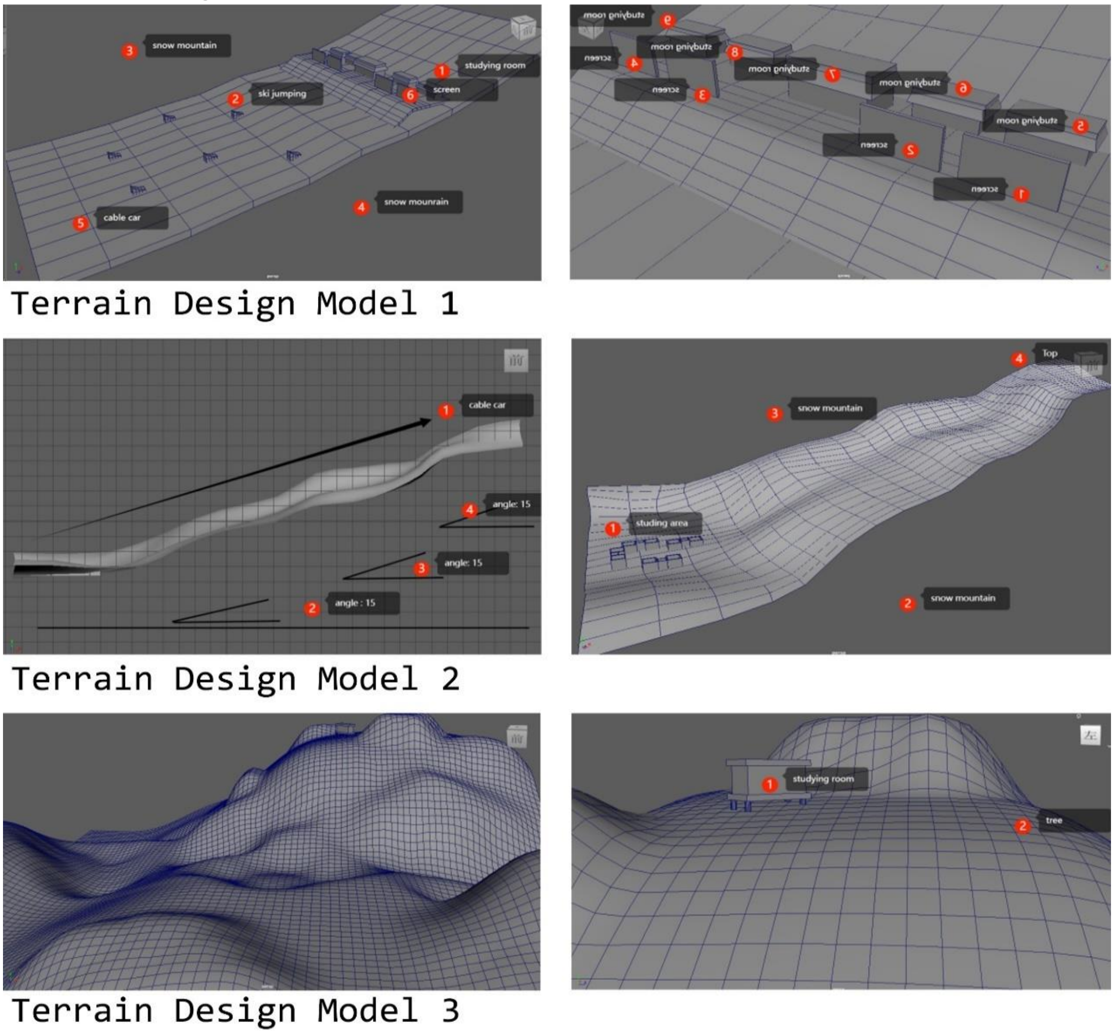


Source: Hand-drawn by the author

The initial terrain was created using the 3D modeling software based on the sketches (Figure 56). The researchers presented the designed 3D model sketches to experts for discussion.

Figure 56

3D Sketch Design



Source: Created by the author

The experts provided the following feedback:

Model 1's terrain was too flat, so although it included jumps, it was not suitable for beginners.

Model 2 had varied terrain with gentle and steep slopes, making it more suitable for beginners.

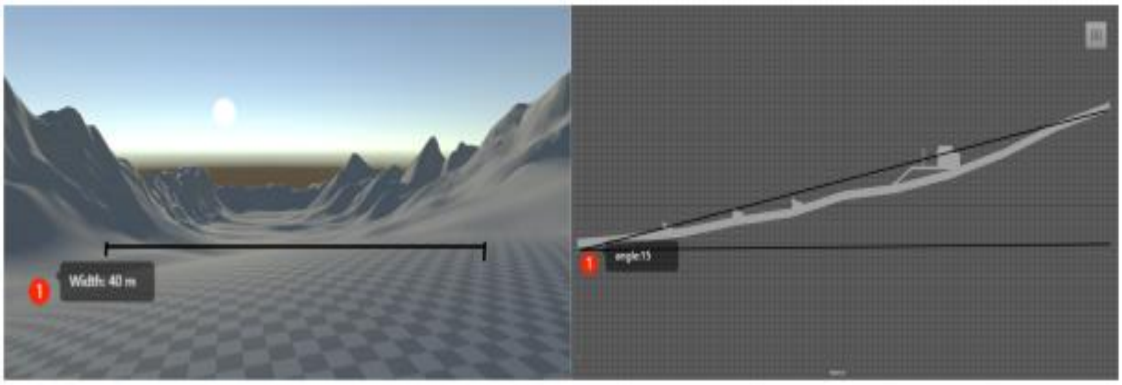
Model 3 had too rough and uneven terrain, making it unsuitable for snowboarding.

Ultimately, the experts recommended further design based on Model 2. The researchers adopted the experts' suggestions and proceeded with terrain creation.

Based on preliminary data research conducted by the researchers, ski resorts were built on snowy mountains, utilizing the slopes of the mountains to establish snowboard trails. The slope suitable for beginners was approximately 15°, providing an appropriate challenge without causing excessive pressure on beginners. This slope helped beginners practice turning and speed control.

The length of snowboard trails generally had no set limit, as the mountain terrain determined the length of the trails in the real world, typically exceeding 1000 meters. The width was greater than that of the VR world. The researchers set the snowboard trail length to 1200 meters in the VR environment. The width of the trails was usually between 25 and 40 m, but we set the width to 40 m (Figure 57).

Figure 57
Terrain Design



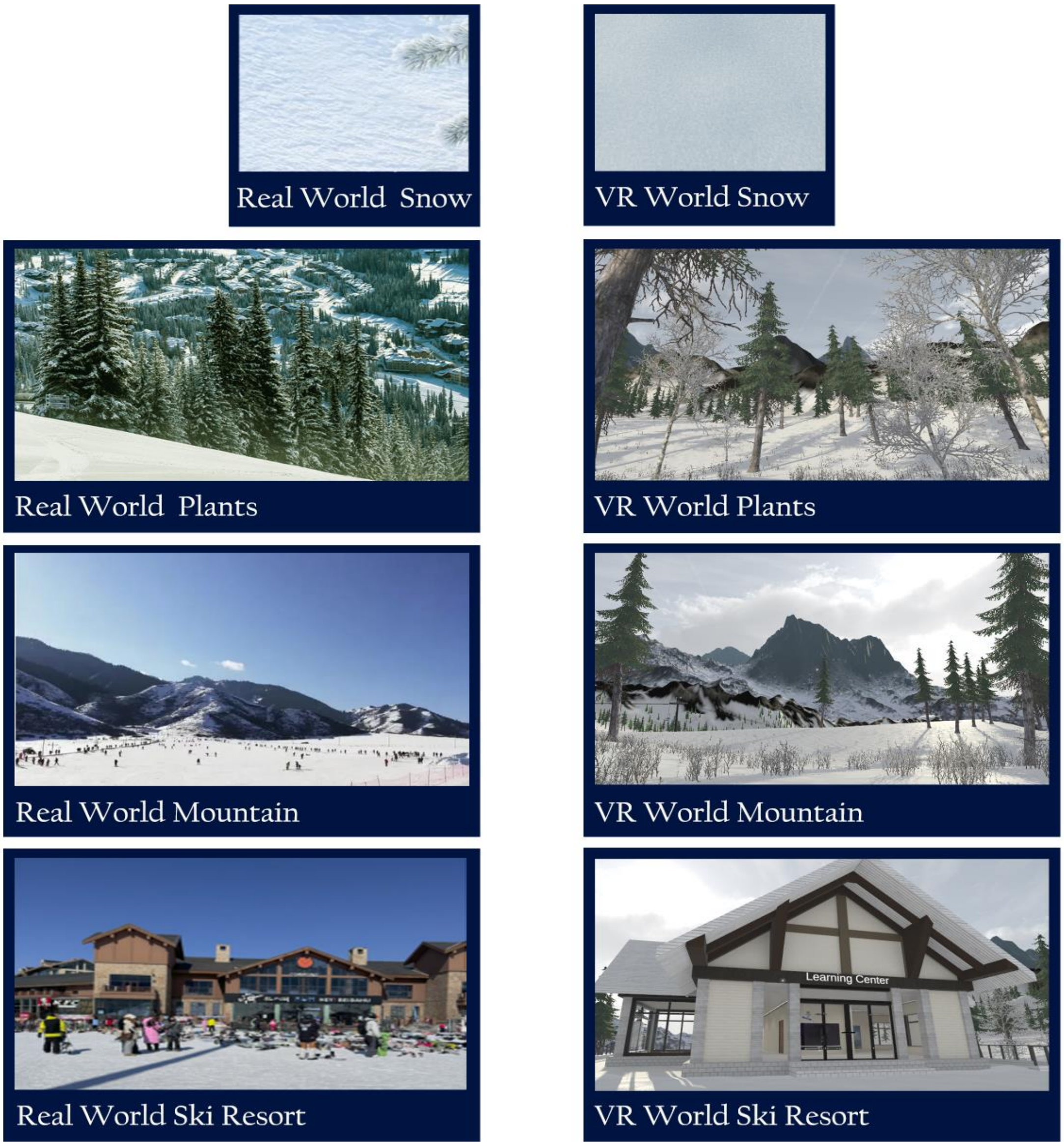
Source: Designed by the author

5.3.2 SNOW SLOP DESIGN

In the design of the environment, the creation was performed by fully simulating the appearance of real-world ski resorts. This is because, in the initial user survey, users clearly expressed their desire to experience a virtual world that completely simulates a real snowboarding environment. Researchers visited some well-known ski resorts and collected various environmental design elements.

Figure 58

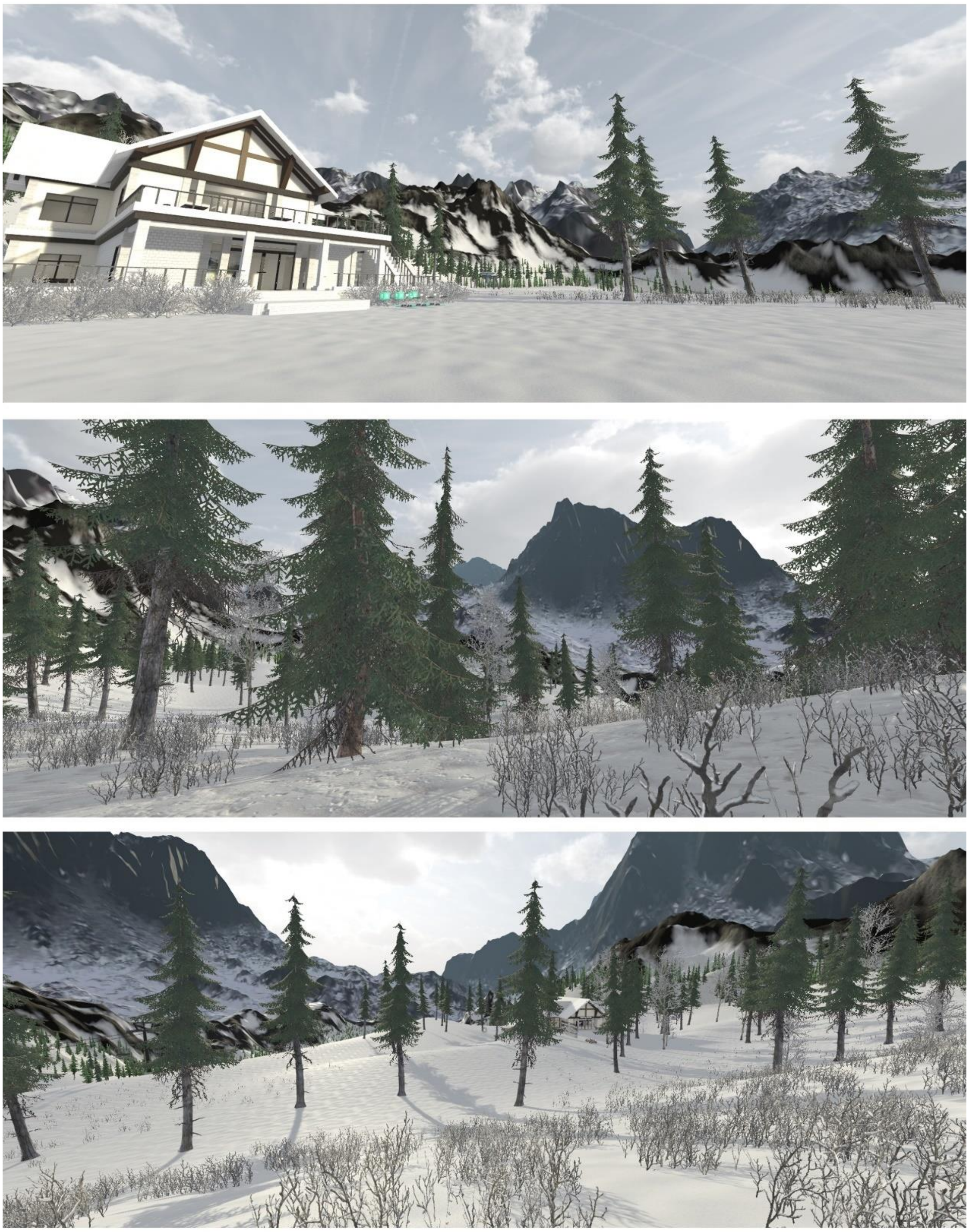
Conversion of Real Elements into Virtual Elements



Source: Designed by the author

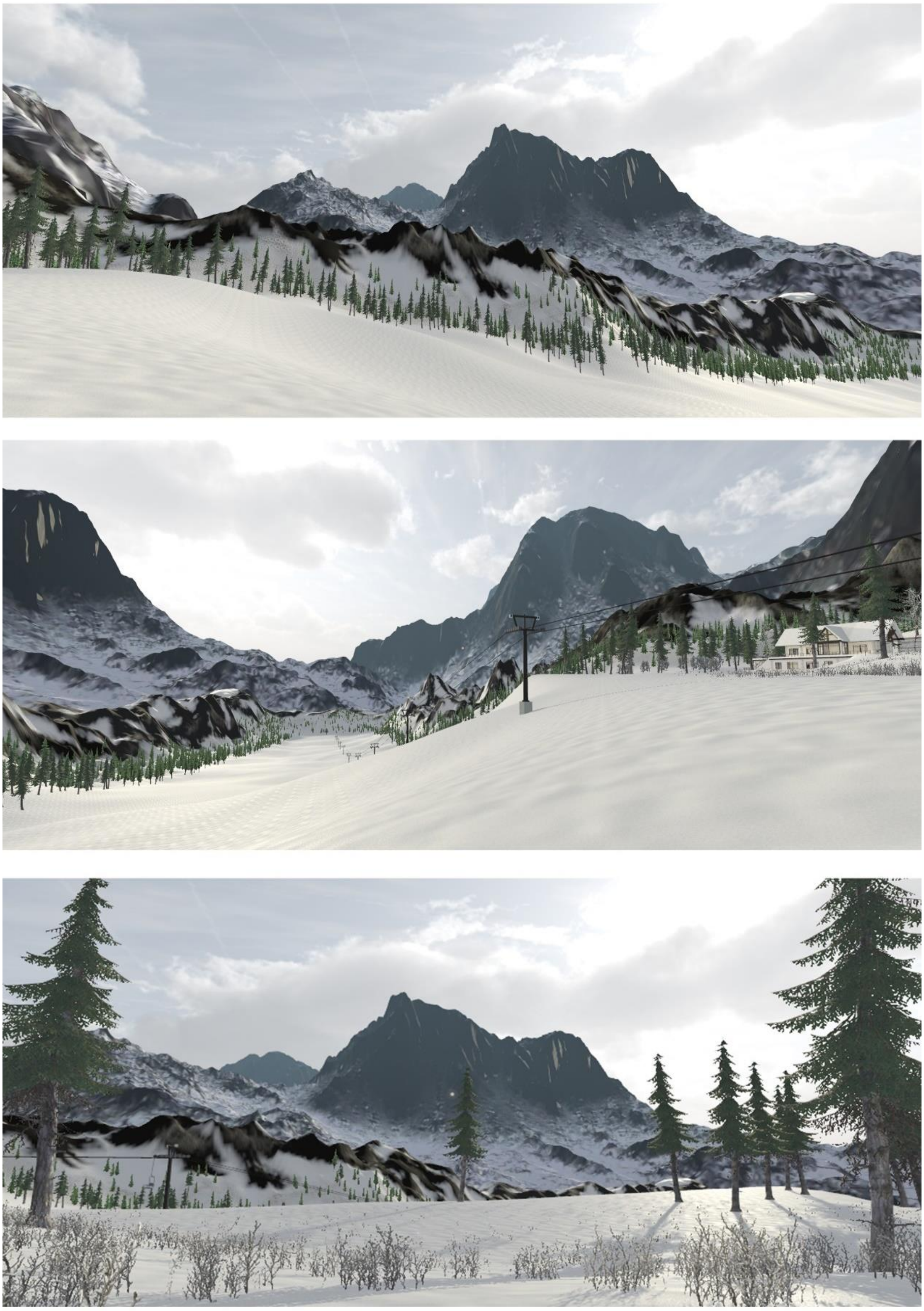
Based on preliminary research conducted by the researchers, all ski resorts were covered with snow and surrounded by mountains. The resorts mainly consisted of snowy areas and resort villages. The surrounding vegetation was predominantly winter plants. The researchers collected snow, plants, mountains, and resort cabins and designed elements in the virtual world based on these materials (Figure 58, 59, 60).

Figure 59
The Environment in Virtual World 1



Source: Designed by the author

Figure 60
The Environment in Virtual World 2



Source: Designed by the author

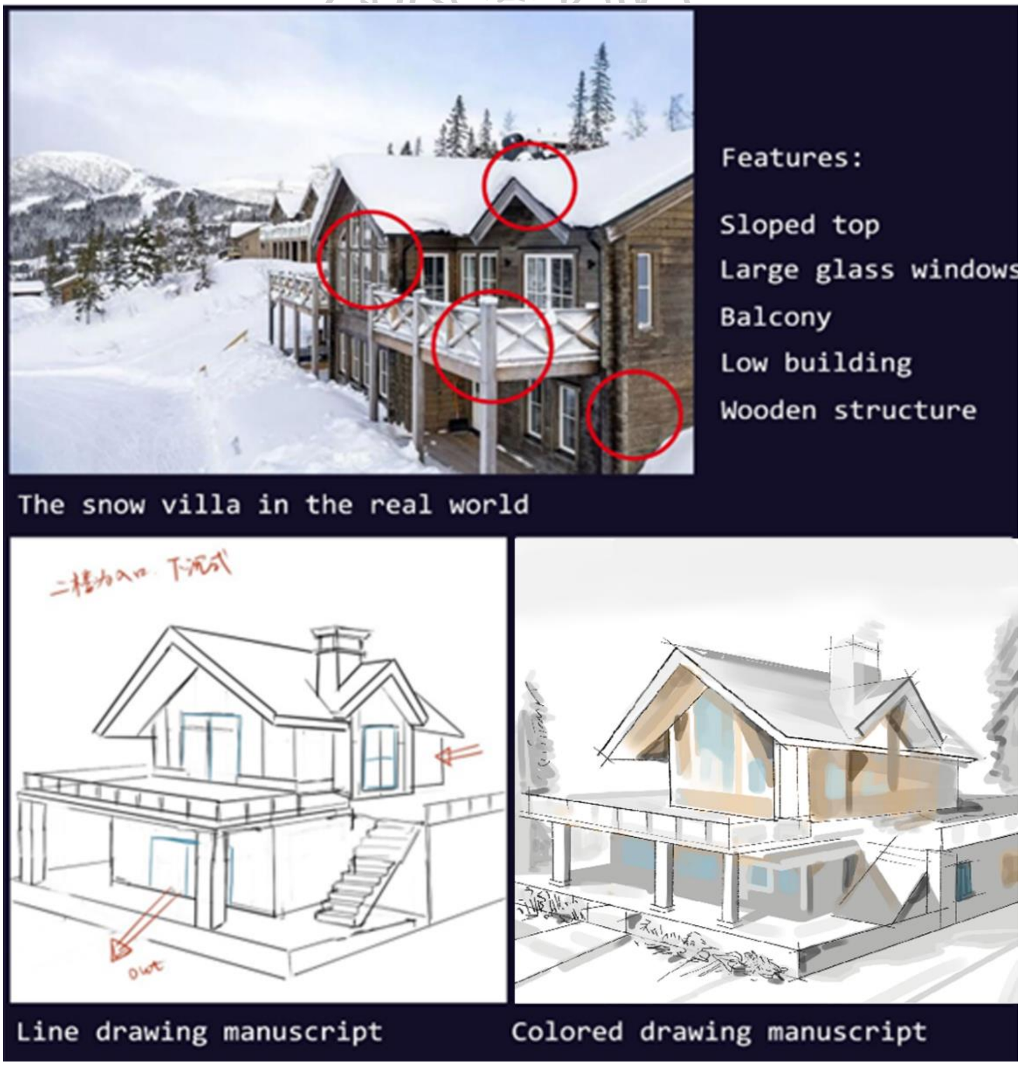
5.3.3 LEARNING CENTER DESIGN

5.3.3.1 THE LEARNING CENTER EXTERIOR DESIGN

Since every excellent ski resort has villas, researchers also incorporated resort villa designs into the virtual world. In the real world, resort villas are primarily used to provide accommodation, leisure, and entertainment, offering a space for players to relax and enjoy. The exterior design elements of the villa were mainly emphasized by the wooden structure, large glass windows, sloping roofs, observation decks, and low floors, which are characteristic of snowboard holiday villas (Figure 61).

Figure 61

The Learning Center Exterior Sketch Design

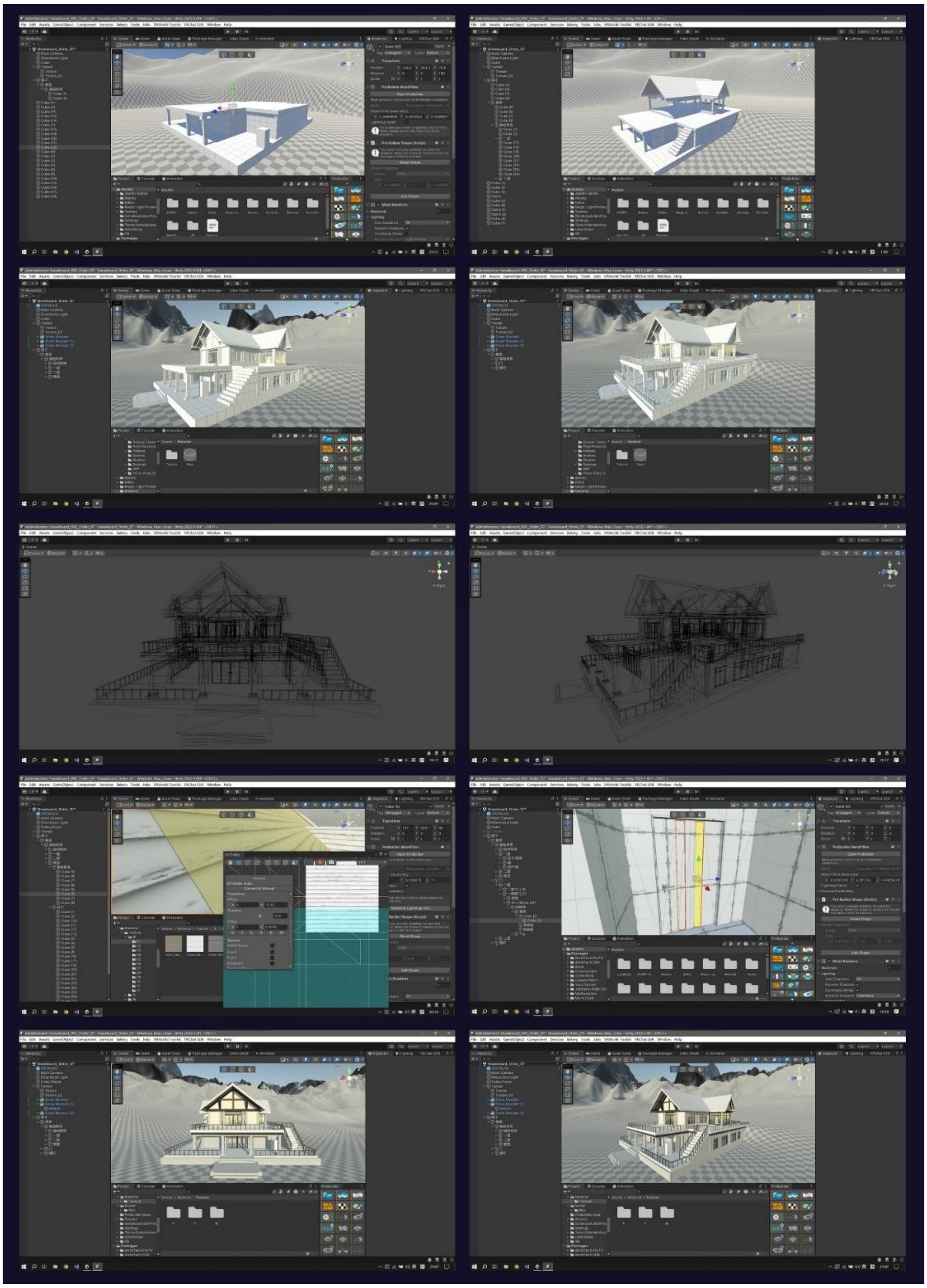


Source: Hand-drawn by the author

The researchers created a 3D model in the software based on the sketch design (Figure 62).

Figure 62

The Learning Center Exterior Design Process



Source: Designed by the author

After the material addition session, the model was rendered to achieve the desired effect in the image. The researchers presented the learning center model from multiple perspectives (Figure 63, 64).

Figure 63

The Learning Center in the Virtual World 1

Source: Designed by the author

Figure 64

The Learning Center in the Virtual World 2

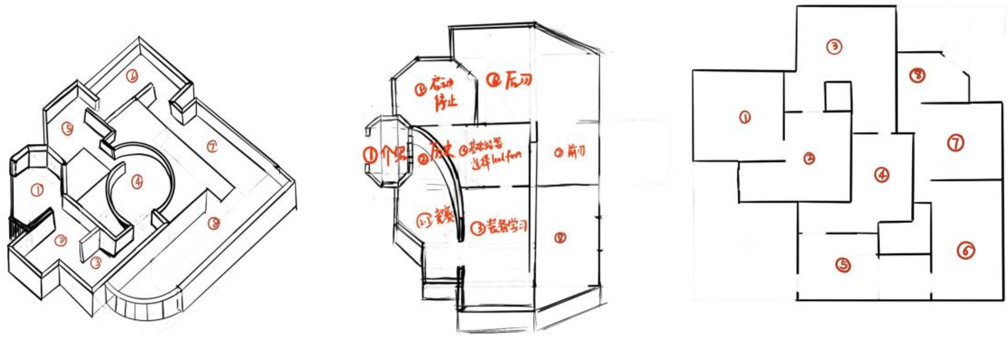
Source: Designed by the author

5.3.3.2 THE LEARNING CENTER INSIDE DESIGN

To achieve a rich educational experience, researchers integrated learning functions into resort villas, allowing users to complete part of their learning while retaining the relaxation and leisure features of resort villas. Users can enjoy a realistic resort experience in the virtual resort villas while participating in various learning activities, thus enhancing the interactivity and educational value of the virtual world.

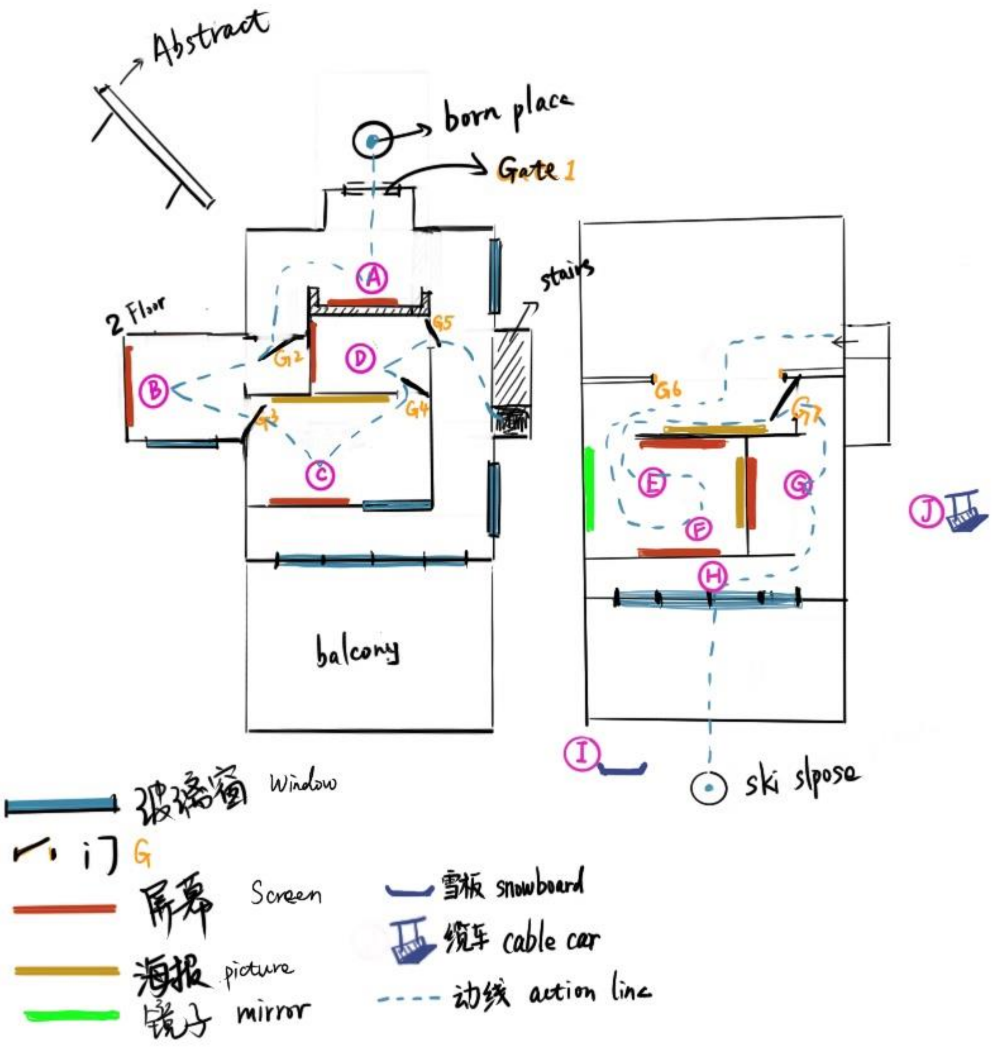
To enhance the user’s learning journey, the researchers planned to use a maze-like map for the interior design of the learning center. The researchers designed three maps (Figure 65).

Figure 65
Sketches of the Learning Center's Interior



Source: Designed by the author

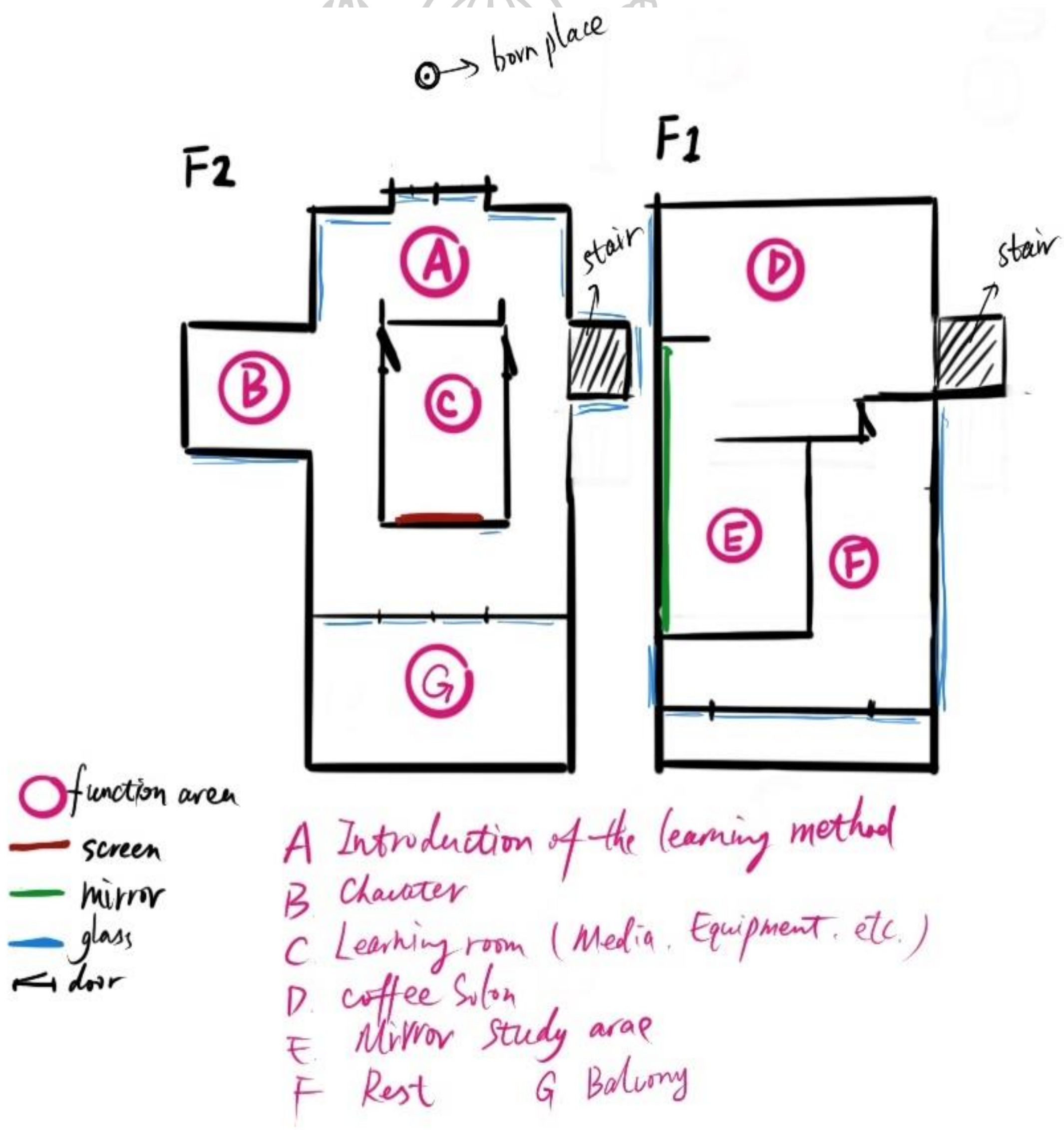
Figure 66
Inter Structure of the Learning Center 1



Source: Designed by the author

The researchers presented the sketches to experts for discussion. The experts believed that the maze-like design of the learning center would fatigue users, reducing their motivation to learn. They suggested modifying the design based on the building's structure. Following the experts' advice, the researchers redesigned the layout. The researchers redesigned the structural diagram and labeled the functions of each area within the learning center (Figure 66).

Figure 67
Inter Structure of the Learning Center 2



Source: Designed by the author

The experts approved the new map; however, during subsequent user testing, users provided the following feedback:

1) There were too many players, and they preferred to include all course content in a single player.

2) The history and competition content of snowboarding took up too much learning time; although it increased their knowledge of snowboarding, they did not want it included in the course.

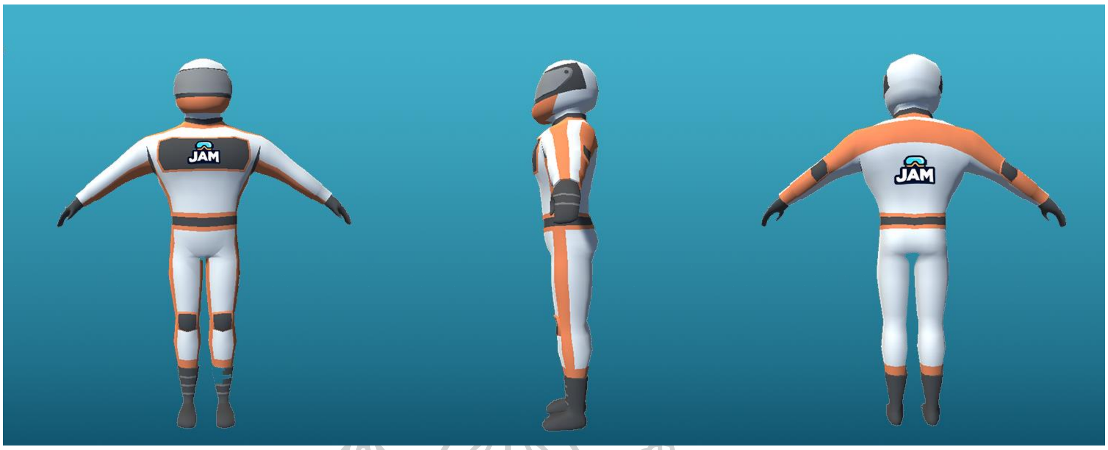
Based on user feedback, the researchers made further adjustments to the learning center's functional area distribution (Figure 67).

5.3.4 CHARACTER DESIGN

Due to the focus of this study on snowboarding instruction design, the binding requirements for character limbs were relatively high. Binding characters typically required multiple positioning points, including the head, neck, spine (upper body and waist), pelvis, left and right shoulders, left and right arms (upper arm, forearm, wrist, fingers), and left and right legs (thigh, calf, ankle, foot). These positioning points were used to synchronize the actions of the virtual characters with the user's movements. Therefore, only character models with the same head-to-body ratio as that of ordinary humans could be used. The researchers designed three game character styles for users to choose from.

Stick figure style is a drawing style that uses simple lines and geometric shapes to depict people and objects (Figure 68). Its characteristics are simplicity, abstraction, and easy recognition. Despite being highly simplified, the graphics clearly convey the characters' actions and emotions. This style is commonly found in educational materials, comics, logos, and diagrams because its straightforward design effectively highlights vital points and core information in visual communication.

Figure 68
Stick Figure Style



Source: Designed by the author

The low poly style is an artistic style that creates simplified, geometric 3D models using a few polygons. This style is characterized by using fewer polygons, making the models appear as though they are composed of flat surfaces and sharp edges, presenting a unique and abstract aesthetic (Figure 69). Low poly style is often used in video games, animations, and VR because of its low computational requirements, which can improve performance while maintaining visual appeal. This style's simplicity and geometric features give it a distinctive artistic effect in visual communication.

Figure 69
Low Poly Style

Source: Designed by the author

Realistic style is an artistic approach that aims for high detail and realism, striving to recreate people, objects, and scenes from the real world as accurately as possible. This style focuses on the accuracy of light, shadows, textures, and proportions, making the works almost resemble photographs or real-life scenes. Realistic style is widely used in painting, sculpture, photography, film, and video games, employing precise details and lifelike representation techniques to immerse audiences in a highly realistic environment (Figure 70). The goal of this style is to create visually convincing and authentic artwork.

Figure 70
Realistic Style

Source: Designed by the author

The researchers sent three types of characters to the 30 target users for selection. Ultimately, 21 target users selected the Stick figure style. Based on the selection results, the researchers proceeded to the next stage of design. They designed five characters representing different body types and ages (Figures 71 to 75). The design of characters' ages, professions, and interests is based entirely on data from target users.

Figure 71

The Character Concept Design 1

Source: Designed by the author

Figure 72

The Character Concept Design 2

Source: Designed by the author

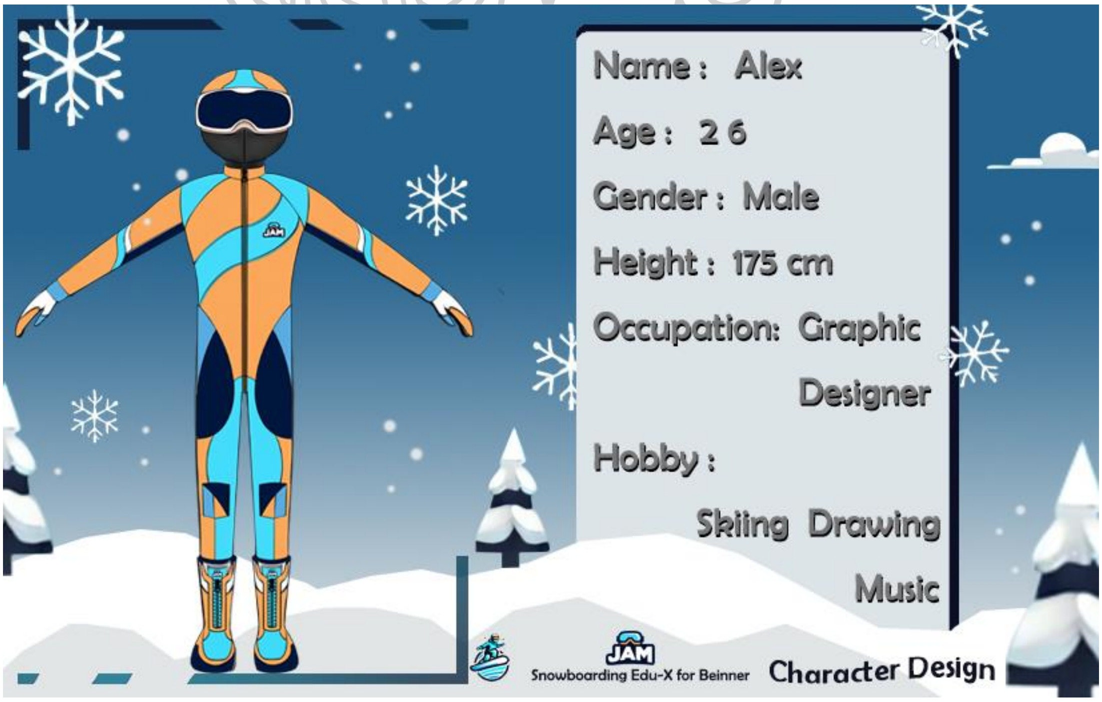
Figure 73

The Character Concept Design 3

Source: Designed by the author

Figure 74

Character Concept Design 4



Source: Designed by the author

Figure 75
The Character Concept Design 5

Source: Designed by the author

The purpose of this approach is:

1) Diverse User Experience: Designing characters with different body types can meet the diverse needs of players, enhancing their immersion and satisfaction. Players can choose characters that are similar to themselves or completely different, thus increasing the game's appeal and entertainment value.

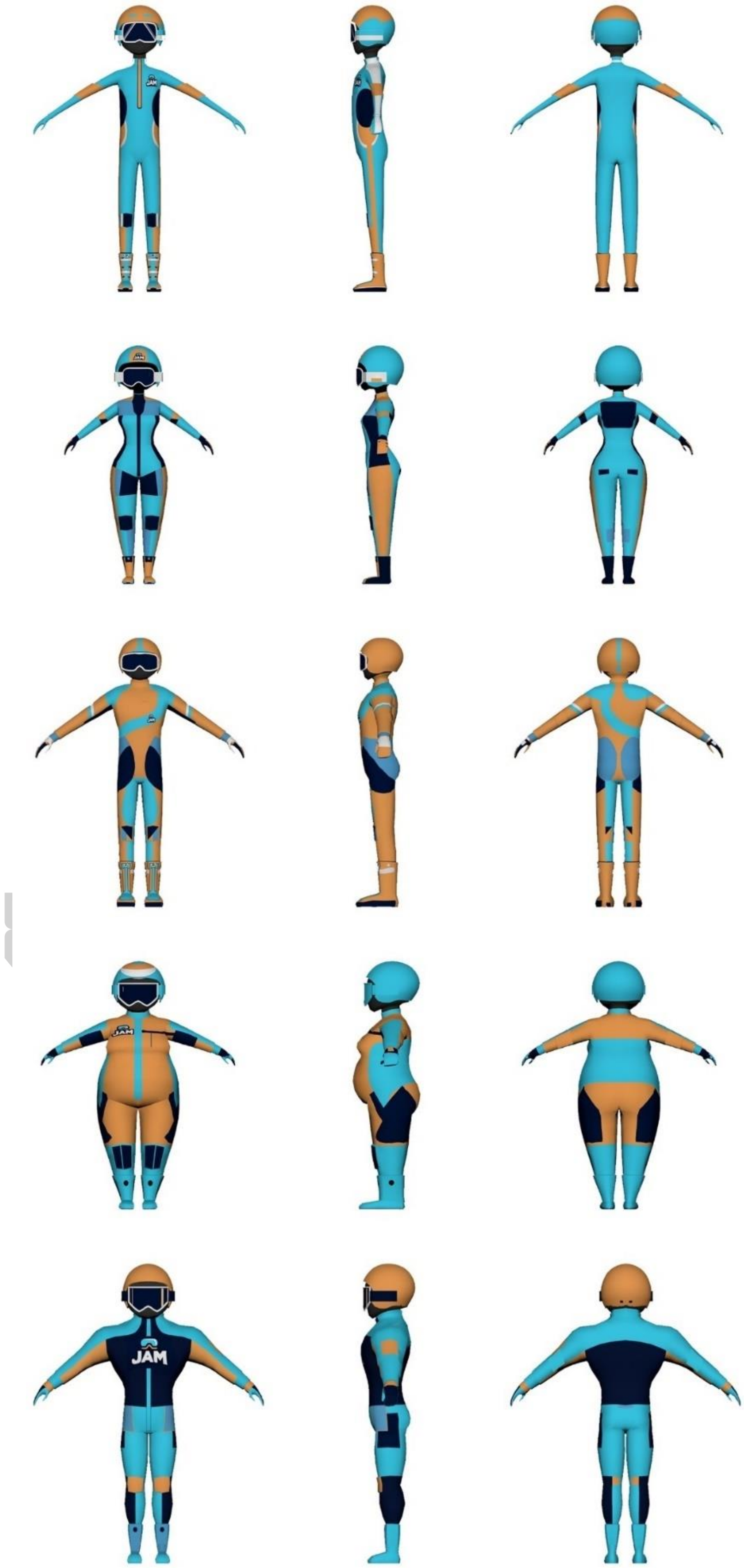
2) Enhanced Identity Recognition: Providing characters with various body types and genders can enhance players' sense of identity. Players can select characters that best represent their interests or preferences, allowing them to better engage in the game.

3) Aligning with Target User Characteristics: The target users are aged 20–35, have a bachelor's degree or higher, and have a medium income. This group typically valued self-expression and diversity. Designing characters with various body types can better meet these needs and preferences, thereby making the game more attuned to target users' expectations.

After the design proposal was approved, the researchers proceeded to put the model into production. The researchers used character blueprints to create the model in design software (Maya). After the designers completed the white model design, they split the UVs and drew the texture. The specific steps in this section are elaborated on in a later section. The following is a demonstration of the 3D character model (Figure 76).

Figure 76

The 3D Character Models



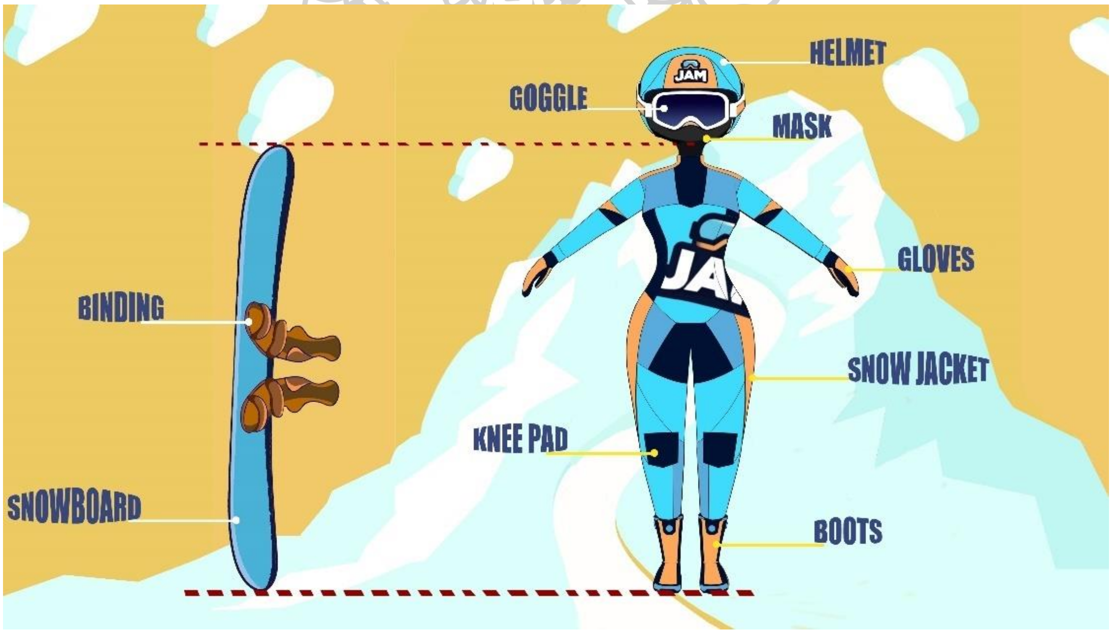
Source: Designed by the author

5.3.5 FIGURE DESIGN

5.3.5.1 EQUIPMENT LEARNING DESIGN

The researchers displayed the blueprints of each piece of ski equipment in a room designated explicitly for equipment so that learners could gain a more intuitive and comprehensive understanding of each item’s uses and functions. Through this visual display method, learners could closely observe the structure and functionality of each ski equipment piece, thereby deepening their impressions and understanding of the ski equipment. This approach enhances learners’ theoretical knowledge and provides better guidance for practical application (Figure 77).

Figure 77
The Equipment Introduction Design



Source: Designed by the author

5.4 USER EXPERIENCE DESIGN

This study focused on research design in a VR environment in which the interaction methods were consistent with real life. The specific operations depend on the VR equipment used by the player. Some devices have gesture and full-body tracking capabilities, allowing players to interact with virtual environments just as they would in the real world. The other devices had gesture-tracking functions, providing an interaction experience nearly identical to the former. Some devices relied solely on handheld controllers for interaction. These various interaction methods ensured that the players could engage with the virtual environment in a manner that closely mimicked real-life interactions, thus enhancing the realism and immersion of the experience.

5.4.1 THE MEDIA DESIGN

The researchers placed a giant screen in one of the rooms of the learning center. The menu on the right side of the screen displays a menu of media. Users can select courses from the menu at will to learn. At the same time, pause, play, and other functions are provided below the screen (Figure 78).

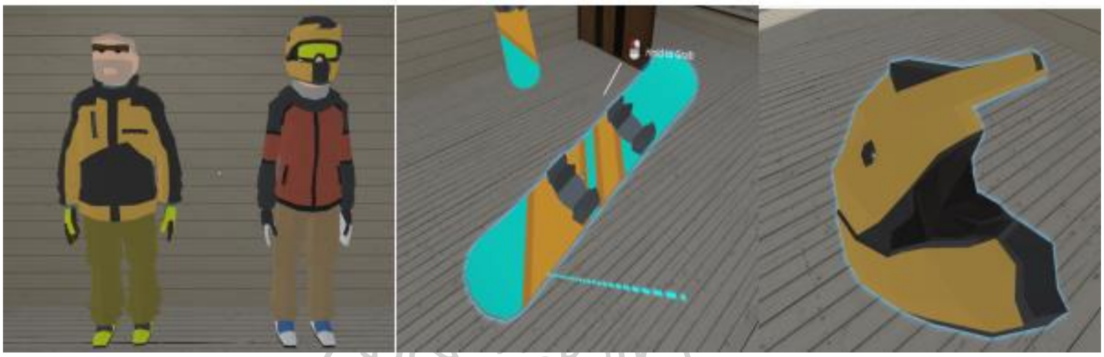
Figure 78
Media Design

Source: Created by the author

5.4.2 OBJECT INTERACTION DESIGN

The environment was constructed to mimic the style of a snowboarding equipment store. The exhibition included display mannequins and interactive equipment. Additionally, usage distribution maps of the equipment were generated (Figure 79).

Figure 79
Design of the Snowboarding Equipment

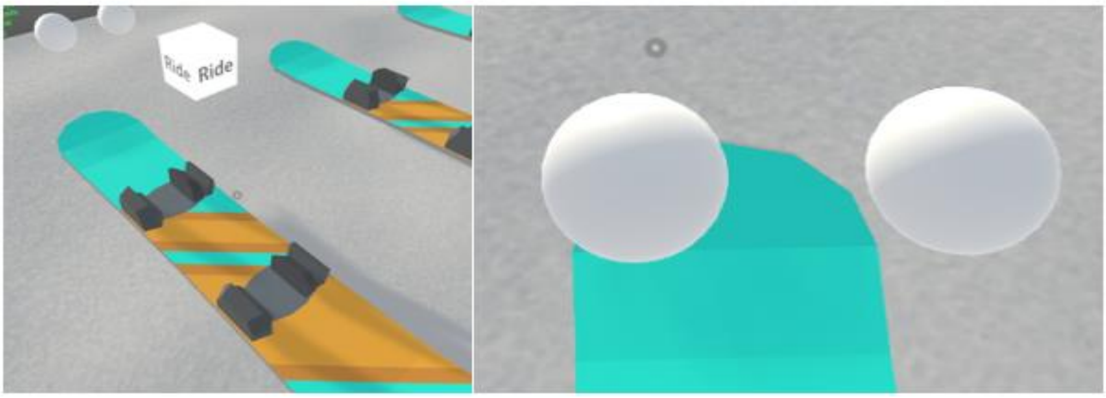


Source: Designed by the author

5.4.3 SNOWBOARD DESIGN

The snowboard design was modeled after real snowboards. Each snowboard was equipped with two spheres. The purpose of these spheres was to allow the player to hold them in their hands while using the snowboard. By controlling their body balance during snowboarding, the player was able to make the spheres swing in balance. This design aimed to simulate the body movements in fundamental snowboarding, enhancing the realism of the experience (Figure 80).

Figure 80
Snowboard Design

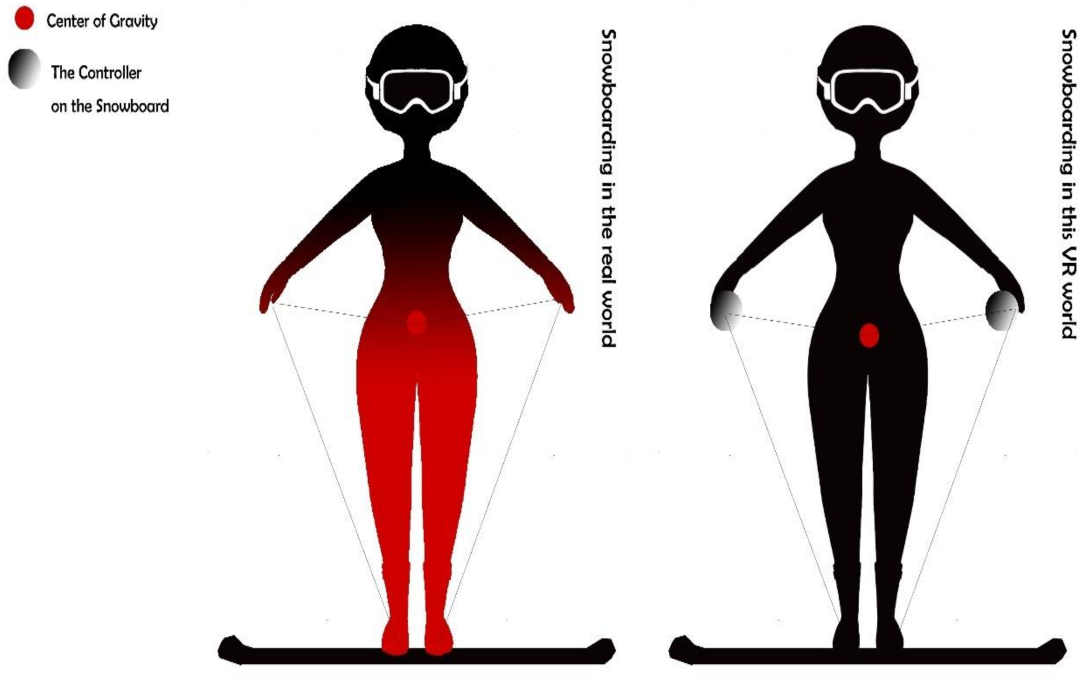


Source: Designed by the author

The principle underlying this design mimics the mechanics of using snowboards to glide in the real world. In reality, the upper body remains stable, especially for snowboarding beginners. Instructors often prohibit using arms when teaching how to glide because arm movements can shift the center of gravity. Therefore, the arms and body can be considered as a single unit. When gliding, people place their center of gravity around the navel and rely on shifting this center of gravity to apply pressure on the snowboard, enabling left and right movements and starting and stopping.

In this study, the researchers designed a center of gravity controller to be held in the player’s hand, as there is no external device to simulate a snowboard. When simulating fundamental snowboarding, the body cannot move freely, and players must hold the controller to manage their center of gravity. This approach aimed to replicate the effects of fundamental snowboarding (Figure 81).

Figure 81
How a Snowboarder Controls a Snowboard



Source: Designed by the author

5.4.4 CABLE CAR DESIGN

The cable car design faithfully replicated the ones used on beginner slopes in actual ski resorts. This provided a realistic training environment, allowing snowboarding beginners to become familiar with actual operations in a virtual setting. Additionally, it effectively enhanced their safety awareness and confidence. The realistic cable car design improved immersion and user experience, enabling users to quickly adapt to the actual ski resort environment. Such design details also helped learners reduce feelings of unfamiliarity and fear when transitioning to real-life scenarios, thus increasing learning efficiency (Figure 82).

Figure 82
The Cable Car Design

Source: Designed by the author

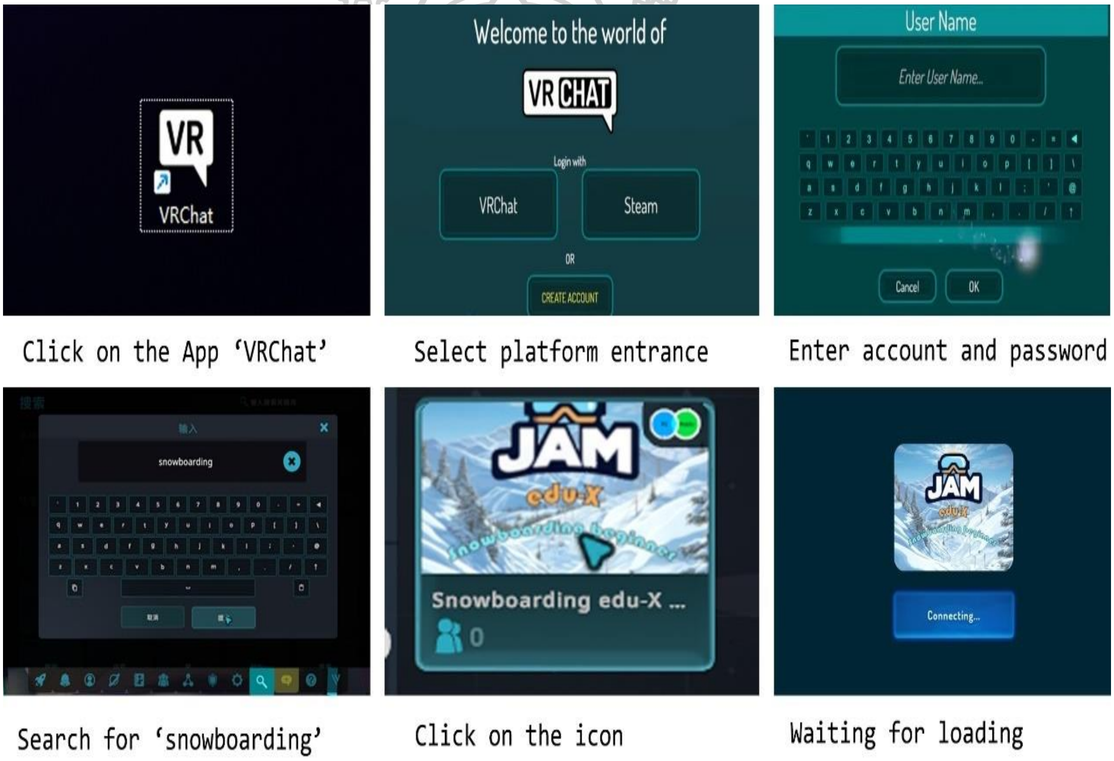
5.4.5 EXPLAIN EACH STEP

This section presents the detailed operational methodology, providing an in-depth explanation of the interrelationship between each step. The procedures for navigating the VR snowboarding environment are illustrated in images, effectively demonstrating the workflow and improving the understanding of the system's functionality.

Users must first install the CRChat app on their VR devices. Currently, VRChat offers several login ports from which users can choose. The next step is the registration and login session. After completing the above steps, the user enters the VRChat operator interface and searches for the veneer chemistry literature for this study. When users find the world, select Enter (Figure 83).

Figure 83

Register and Login



Source: Designed by the author

When users load up the world, they are in a first-person view and appear at the birth point. Users can see the learning center and a part of the snowy mountain landscape (Figure 84).

Figure 84

Point of Birth in Virtual Reality World

Source: Designed by the author

A giant, semi-transparent billboard is to the left of the birth point’s perspective. This billboard features an abstract of the snowboarding education experience in a VR environment, providing users with an understanding of the significance and purpose of the VR snowboarding environment (Figure 85).

Figure 85

Abstract of the Virtual Reality World

Source: Designed by the author

Users must walk toward the learning center and open the door. The VR equipment determines the interaction at the point the user is using. If it is a generic controller, the front button clicks on the door handle and performs the pull-open action. If the user uses motion capture equipment, they can open the door handle (Figure 86).

Figure 86
Enter the Learning Center

Source: Designed by the author

Figure 87

Learning Methods of the Virtual Reality World

Source: Designed by the author

Upon entering the learning center, the user is first introduced to the learning methods. The learning method involves six steps. The researchers advise users to follow the learning method strictly when using this VR environment. Users obtain the best learning effect (Figure 87).

Figure 88

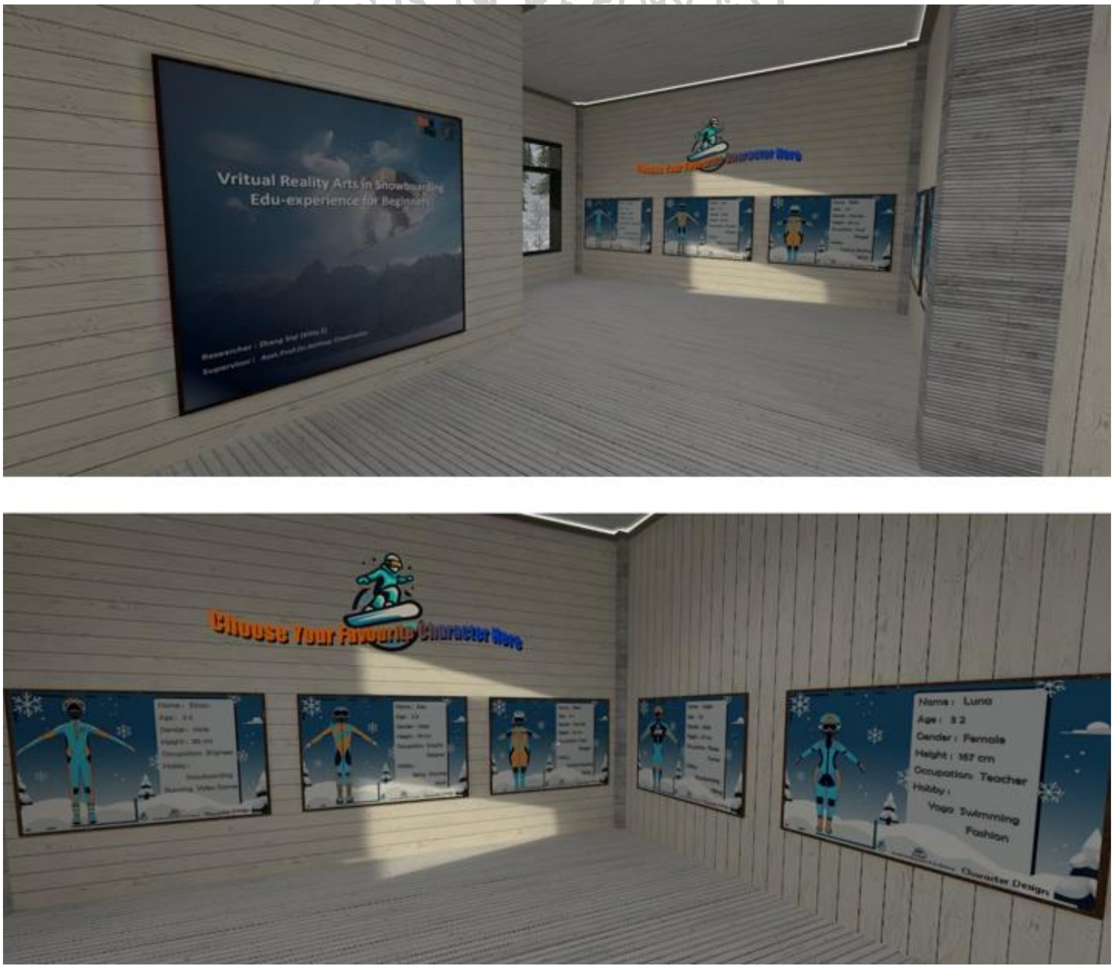
View from Left to Right

Source: Designed by the author

Once users understand the learning method, exploration can begin. Move left to reach other locations. Alternatively, move to the right to start the learning journey (Figure 88).

After understanding the learning methods, users can proceed to the right, where they will find the character selection area. This VR environment offers five characters from different backgrounds that users can choose from. Users can select a character based on their personal preferences or can substitute these characters with custom avatars. The choice is entirely at the discretion of the user (Figure 89).

Figure 89
View from Right to Left



Source: Designed by the author

Users can change the character they use at any time. The character is common to all worlds (Figure 90).

Figure 90
Choose a Character

Source: Designed by the author

Users can access the room opposite the character area, which contains learning content. The first learning content is an introduction to snowboarding equipment. The pictures indicate the guidelines for wearing each type of equipment and the method for selecting a snowboard (Figure 91).

Figure 91
Snowboarding Equipment

Source: Designed by the author

Users can observe various snowboarding equipment in a room to interact and engage in a virtual experience. This interaction facilitates the immersive functionality of the VR environment, allowing users to explore and familiarize themselves with the equipment in a simulated setting (Figure 92).

Figure 92
Interaction with Snowboarding Equipment

Source: Designed by the author

Users can see a massive screen in the room. The playlist on the right side of the screen is a media player. This is a list of what must be learned using the media. Users can select media content according to their learning path (Figure 93).

Figure 93

Media Player and the Playlist

Source: Designed by the author

When users are using the media for learning, when the word Test Time appears on the screen, it means that it is time to answer the question. Questions based on the content of this media study will appear on the screen, and users can answer them (Figure 94).

Figure 94

Test Time Part of the Media

Source: Designed by the author

When users learn through media, the appearance of the phrase "Imitation Practice" on the screen indicates that it is time to begin motion imitation exercises. Users should prepare their body posture and then follow the subsequent guided practice. This follow-along practice can be replayed as required, and users can adjust the exercises according to their learning pace (Figure 95).

Figure 95

Imitation Practice Part of the Media

Source: Designed by the author

Figure 96

Mirror Practice Area

Source: Designed by the author

The mirror practice area is at Level 1 of the learning center. Users can reach this area by ascending stairs. Users can see their entire body in this area, which makes it easier to practice the movements (Figure 96).

The observation deck, located on the first floor of the learning center, allows users to observe the entire world of snowboarding (Figure 97).

Figure 97

The Balcony of the Learning Center

Source: Designed by the author

Figure 98

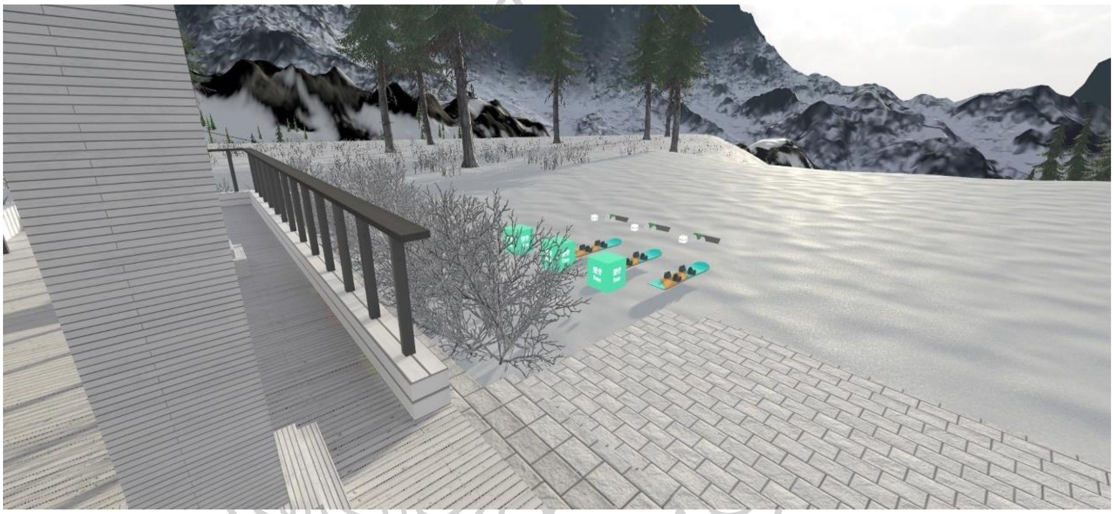
Lounge Area on the Ground Floor

Source: Designed by the author

The next door to the mirrored practice area is the lounge area of the learning center. Users can cross this area to reach the outdoor snow slopes (Figure 98).

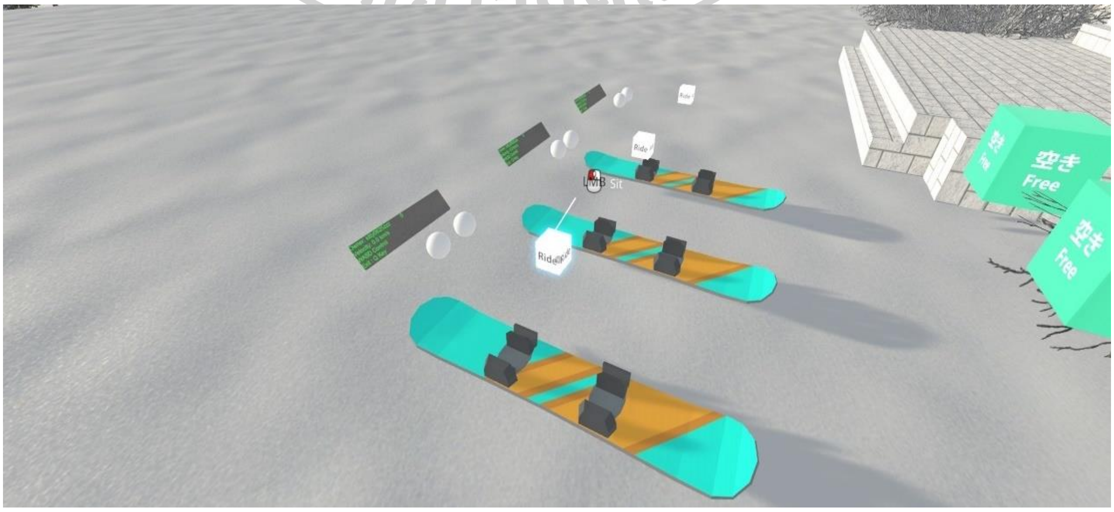
When the user exits the ground floor doors of the learning center, they will see three snowboards on the left side of the display. Users can select any of the snowboards to use in the demonstration (Figure 99).

Figure 99
Snowboard Area



Source: Designed by the author

Figure 100
Snowboard



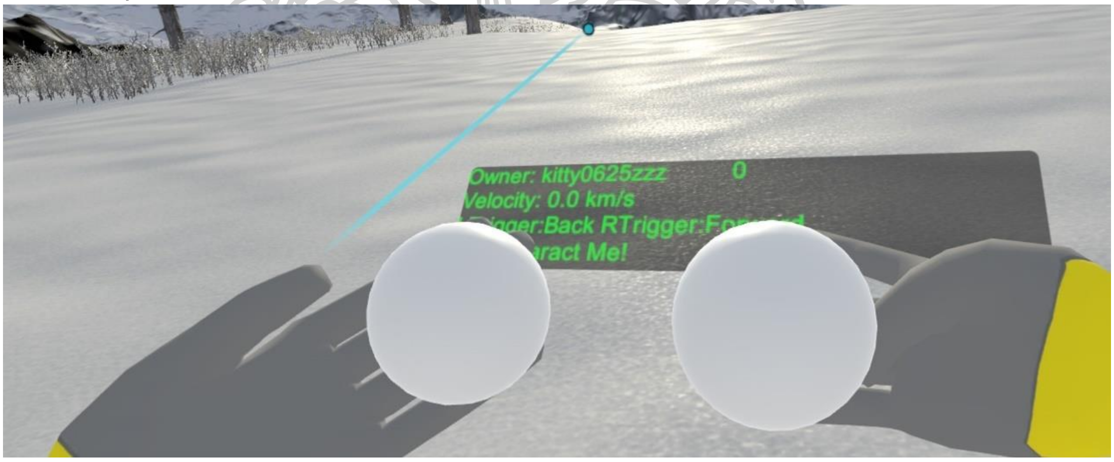
Source: Designed by the author

Users can observe a cube located near a snowboard. If the cube appears pink, the user is either using the snowboard or not in its original position. The user can click on the cube to reset the missing snowboard to its initial state. The snowboard is idle and available if the cube is displayed in green (Figure 100). Users can see a smaller white cube above the snowboard labeled “Ride.” Users can now click on the cube to use the snowboard.

Once the user is on the snowboard, they will see two white spheres on the front of their snowboard. These are the controllers used to maneuver the snowboard. The user must grip the left and right spheres with their left and right hands, respectively. The balance angle between the two hands controlled the direction of the snowboard glide. The researchers described this operational theory in detail in the User Experience Design section of the previous chapter (Figure 101).

Figure 101

Control of the Snowboard



Source: Designed by the author

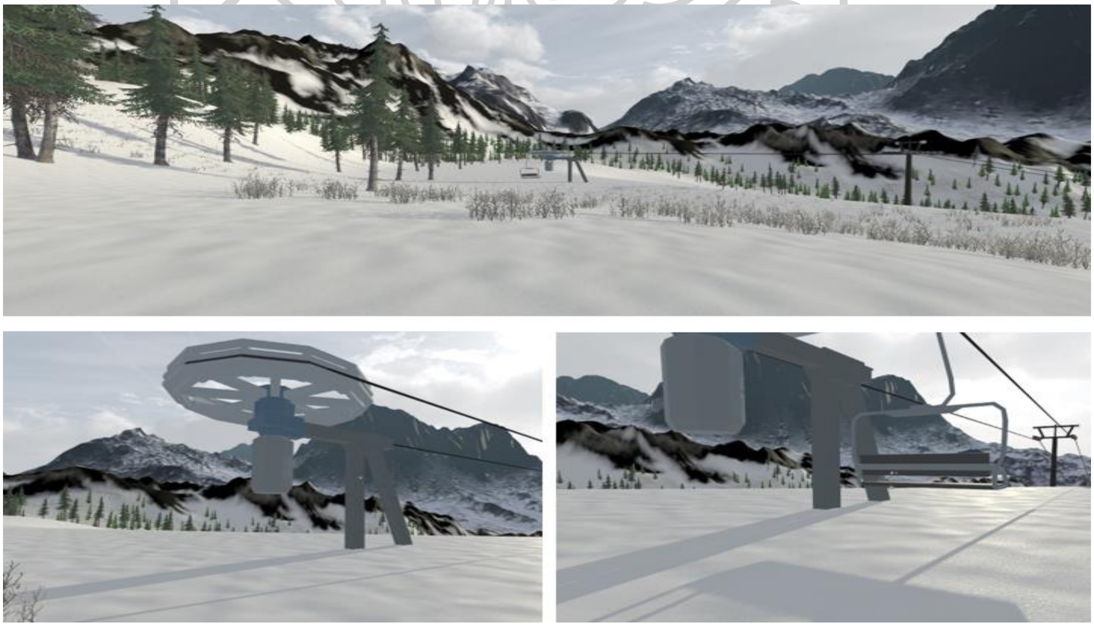
The slopes in the world are completely designed for beginners. Users practice snowboarding on the snow slope (Figure 102).

Figure 102
Snow Slope

Source: Designed by the author

In the VR environment, users can observe a cable car. They can reach the cable car by driving a go-kart or riding a snowboard. The cable car operates continuously from the mountain summit to its base. Users can approach the cable car seats at the summit or the base. When the cable car approaches, a boarding icon will appear on the seat. By clicking on this icon, users can board a cable car (Figure 103).

Figure 103
Cable Car



Source: Designed by the author

5.6 DEVELOP

5.6.1 CHOICE OF DEVELOPMENT PLATFORM

The researchers ultimately chose the VRChat platform to develop virtual reality educational experiences rather than creating an independent development platform. This decision was based on several important factors. Here are the reasons for this choice (Table 8):

Table 8
Development Platform Comparison

	VRChat Platform	***Independent Development Platform***
User Base	○	-
Cost-Effectiveness	○	-
Social Interaction	○	-
Technical Platform	○	○
Content Innovation	○	○
Rapid Deployment	○	-
Scalability	○	○

Note. '○' Means a significant advantage; '-' Means do not have any advantage.
Source: Compiled by the author

1) User Base

VRChat already had a large user base; thus, there was no need to build a new one from scratch. The existing community can help quickly promote educational content and attract users interested in snowboarding.

2) Cost-Effectiveness:

Independent development requires significant upfront investment, including design, development, and testing. Using an existing platform like VRChat allowed the researchers to leverage its developer community, ready-made environments, and tools, significantly reducing development and maintenance costs.

3) Social Interaction:

VRChat was a social platform that offered rich interactivity, which helped simulate a realistic snowboarding teaching environment, making learning more dynamic and engaging.

4) Technical Platform

VRChat provides a stable technical platform, including virtual reality support, audio communication, and user interaction handling. This allowed the researchers to focus on developing educational content rather than dealing with basic technical issues.

5) Content Innovation

The VRChat's open nature encourages innovation and content creation, allowing educators to customize courses and experiences to meet educational goals.

6) Rapid Deployment

Utilizing VRChat enabled rapid prototyping and deployment, which is crucial for the iterative development and testing of snowboarding educational content.

7）Scalability

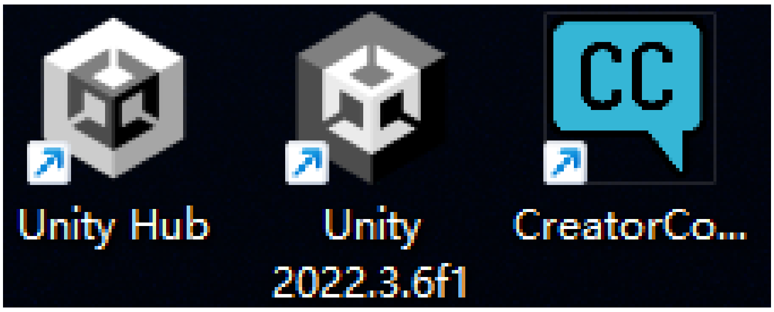
As educational needs change and grow, platforms like VRChat have made expanding or updating educational content and features more accessible.

5.6.2 DEVELOPMENT PROCESS

This section describes the specific implementation steps of the development. Throughout the development process, UnityHub and VRChat Creator Companion were the main software applications (Figure 104). VRChat Creator Companion (VCC) is a multifunctional tool designed to enhance the content creation process for VRChat. Its key functions include Project Management, Unity Integration, Package Management, and Development Support.

Figure 104

The Development Software



Source: Screenshot from the author’s computer

Next, the researchers began to create the project. Open Unity or the VRChat Creator Companion, create a new 3D VRChat World project and import the VRChat SDK and the corresponding VRChat map project plugin (Figure 105).

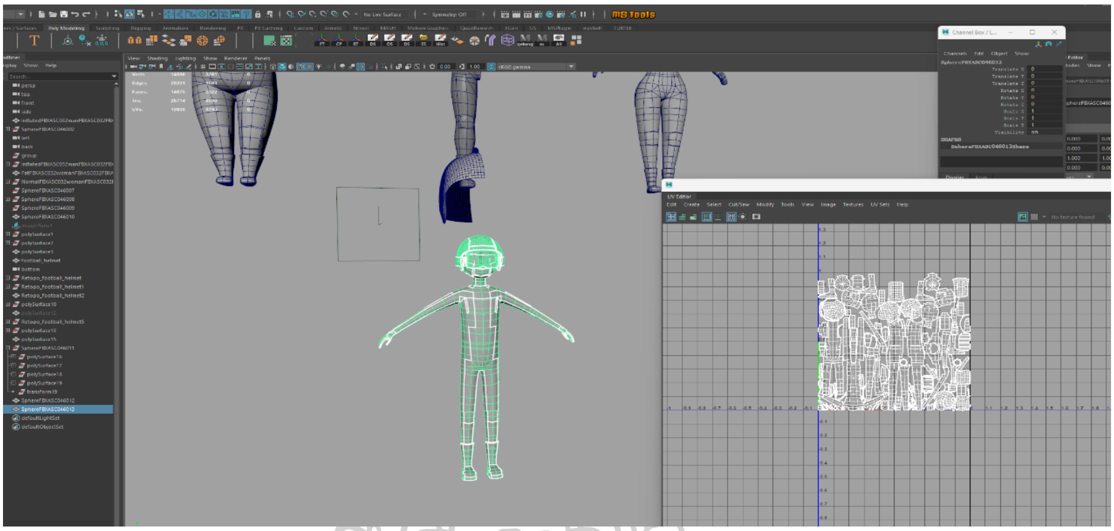
Figure 105

Creating Projects

Source: Screenshot from the author’s computer

Figure 106

Creating Models



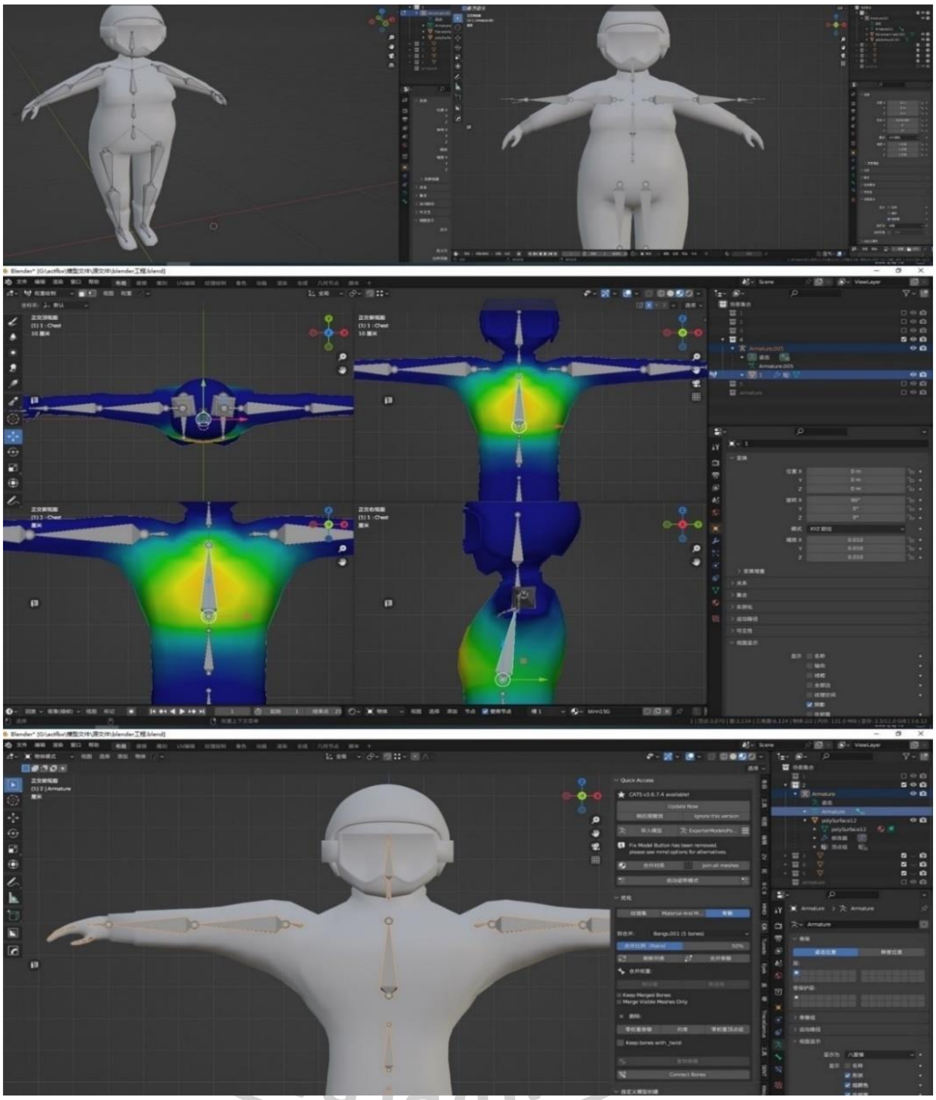
Source: Screenshot from the author's computer

In the modeling phase of the project, software tools such as Maya and Pro Builder, a modeling plugin in Unity. Models were created based on the design drawings or the provided reference images. The developers focused on maintaining a moderate polygon count to ensure that the models did not have excessive details that could affect performance. Additionally, careful attention was paid to the topology of the models to avoid non-streamlined geometric shapes, thereby ensuring a smooth and efficient rendering process (Figure 106).

All normal directions were consistently and correctly oriented to ensure accurate lighting effects on the model surface. Smooth normals were used to enhance the appearance of the surfaces, enhancing their smoothness, while custom normals were applied where necessary to achieve more precise lighting effects. After creating the character model and applying the materials, the model was rigged by binding a skeleton. The model was then imported into Unity, where the avatar was configured, and the skeleton was bound properly. Subsequently, the model was imported into Blender for weight painting and adjustments to optimize the weight distribution (Figure 107).

Figure 107

Rigging Character Models

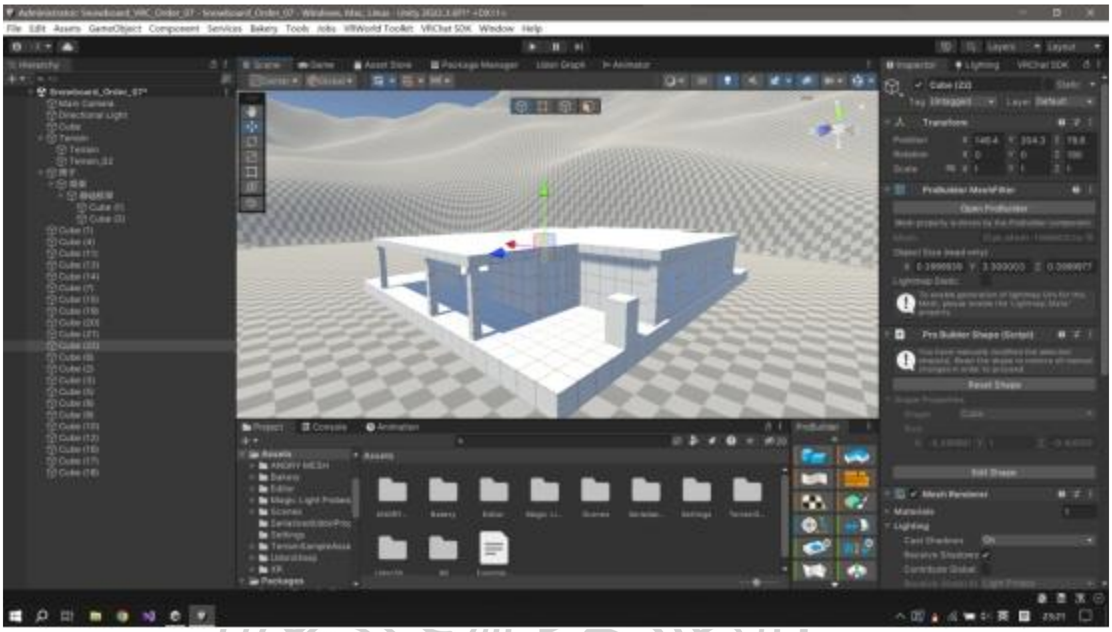


Source: Screenshot from the author's computer

Unity's built-in terrain tools, along with external plugins like Terrain Toolkit, were used to create terrain. The developers set an appropriate terrain size to ensure a balance between performance and detail, and a height map was used to generate variations in terrain height. Different types of ground textures, such as grass, dirt, and sand, were painted using terrain tools. Additionally, the terrain was decorated with trees, bushes, rocks, and other natural elements to enhance its liveliness and realism.

To further improve performance, the level of detail (LOD) technology was employed to reduce the detail in distant terrains (Figure 108).

Figure 108
Developing the Terrain



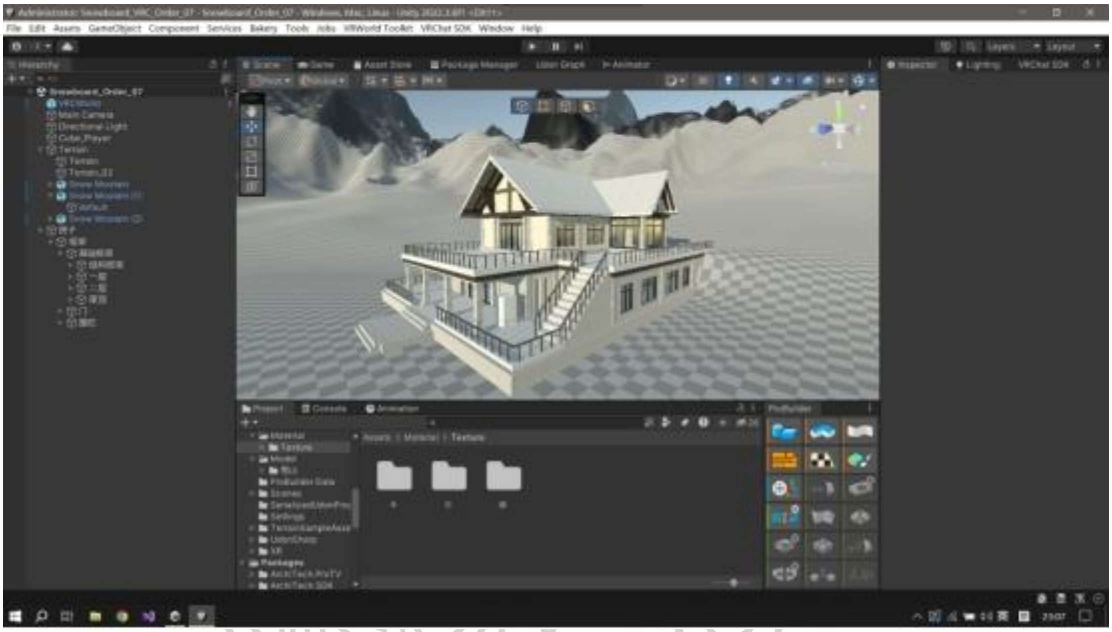
Source: Screenshot from the author's computer

The learning center was modeled using a modular approach, dividing the house into different modules such as walls, roof, windows, and doors, which were each modeled one by one to ensure correct proportions and coordination with character size. Appropriate levels of detail were added to the houses based on viewing distance; distant houses were simplified, while those viewed closer received refined details. High-quality texture maps were created for different parts of the house, incorporating normal and specular maps to enhance detail (Figure 109).

Performance optimization was a key consideration throughout the process. Static objects were marked as static, which allowed Unity to batch them during rendering and reduce draw calls. Lightmaps were used to pre-calculate and store lighting information, thereby reducing the cost of real-time lighting calculations. Occlusion culling was implemented to avoid rendering unseen objects. Smooth normals were used on smooth surfaces to achieve more natural lighting effects, while hard edge normals were applied to parts requiring clear boundaries to emphasize geometric shapes.

Figure 109

Development of the Learning Center



Source: Screenshot from the author’s computer

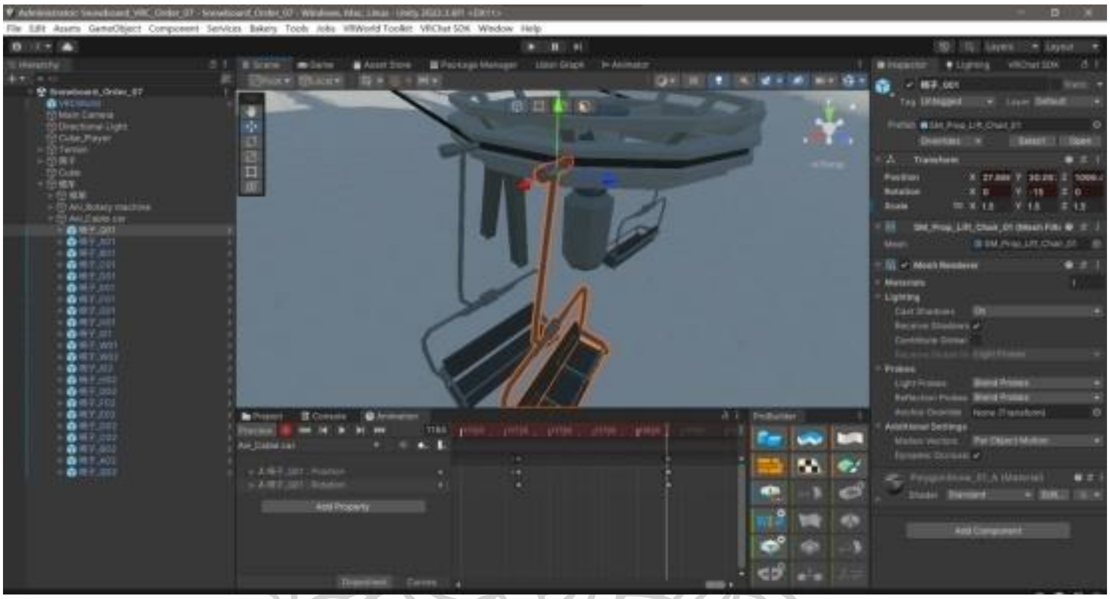
Continuous performance testing in VRChat and gathering feedback were integral to the development process to ensure optimal performance and user experience. This iterative approach helped in making necessary adjustments and improvements to the model over time.

Animations were created using Unity’s animation tools and external tools, such as Blender. The animation controller was then set up in Unity, where the animation state machine was configured. The animations were applied to the model to ensure that they were smooth and satisfied the expectations (Figure 110). Following the animation phase, the model was imported into Unity, and appropriate materials were added. Care was taken to ensure that the shaders and performance of the materials met

VRChat's specific requirements. This process was crucial for achieving a visually appealing and functionally robust virtual experience (Figure 111).

Figure 110

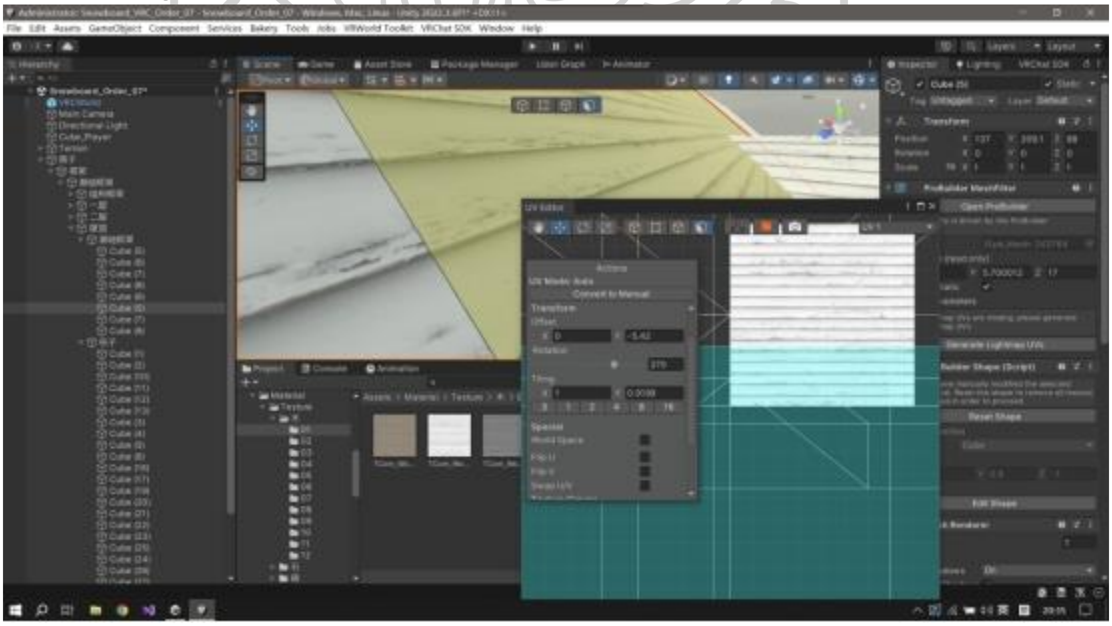
Development of Cable Car



Source: Screenshot from the author's computer

Figure 111

The Learning Center Materials

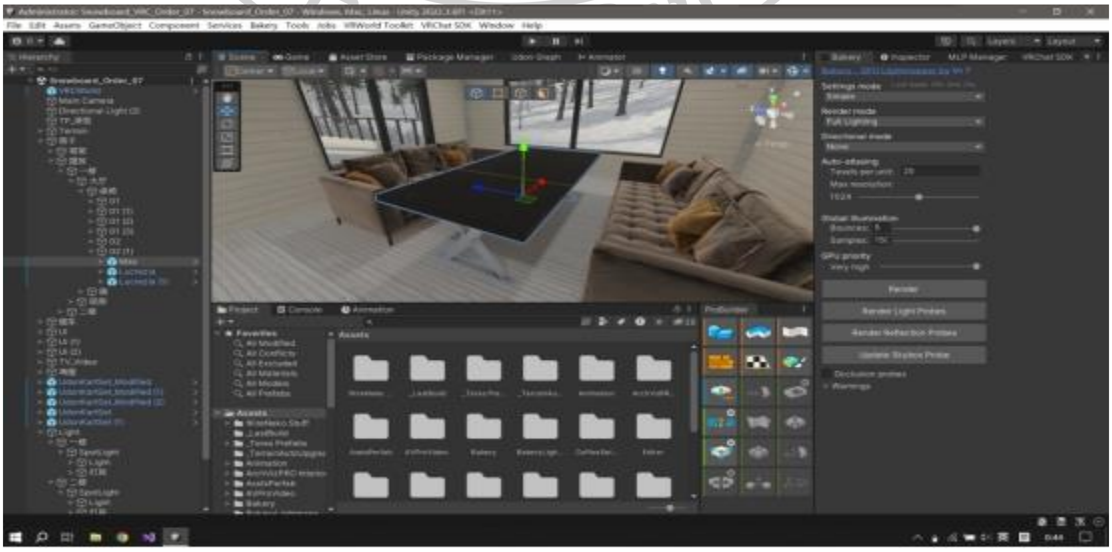


Source: Screenshot from the author's computer

In the development process for VRChat, the Unity Standard Shader or specialized shaders from the VRChat SDK were selected for optimization to ensure good performance and visual effects in VR environments. Complex shaders that require extensive calculations or have unnecessary effects were avoided to maintain efficiency. Material parameters such as color, glossiness, and transparency were reasonably set to balance visual effects and performance, using Unity's material ball for quick previews and adjustments. Texture resolution was moderated to maintain visual quality without compromising performance.

For models that included transparent or semi-transparent materials, the transparency sorting mode in the shader settings was carefully configured to prevent rendering errors due to depth sorting issues. The reflection and glossiness parameters were adjusted based on scene requirements to make the model appear natural under various lighting conditions. After the materials were applied, performance tests were conducted on the target device to ensure that the materials performed well. If performance issues were detected, the number of materials was reduced, or the use of textures and shaders was further optimized to enhance performance (Figure 112).

Figure 112
Performance Testing and Optimization



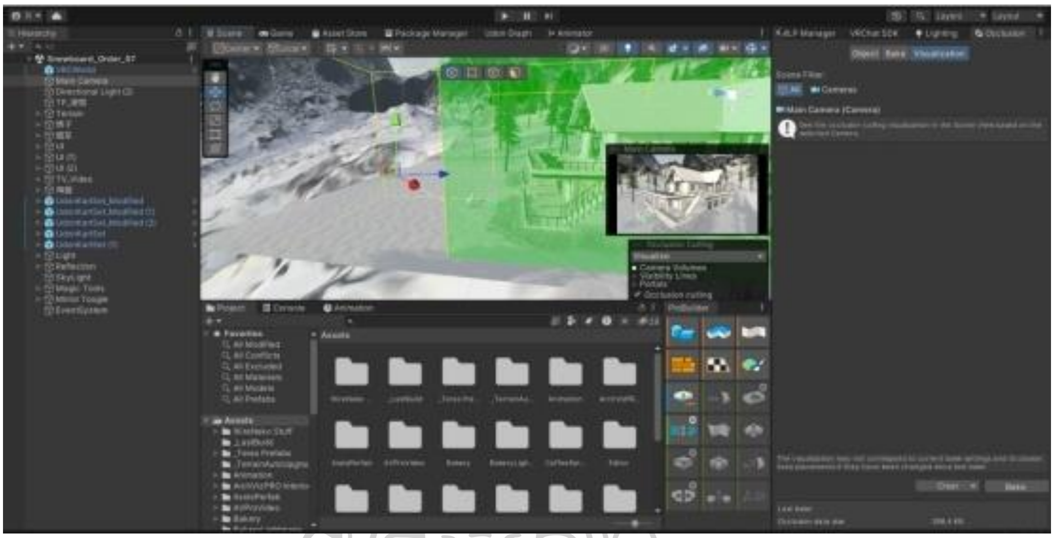
Source: Screenshot from the author's computer

VRChat prefabs, including player spawn points and interactive objects, were strategically placed within the scene to ensure that they aligned with the creative vision. For rendering, the Bakery plugin was used in Unity to generate and adjust lightmaps, encompassing global illumination, indirect lighting, and shadows, to ensure that natural light and shadows were consistent with the scene's atmosphere. Prior to rendering, each object in the scene was optimized by reducing the polygon counts, merging the meshes, and implementing the level of detail (LOD) techniques. Bakery's features, like texture compression and automatic UV unwrapping, were utilized to enhance rendering efficiency and performance.

Dynamic lighting, including moving lights and flames, was integrated using Bakery's real-time lighting technology to ensure accurate reflection in the scene. After rendering, Unity's built-in post-processing effects and other third-party post-processing plugins, such as color grading, bloom, and field depth, were applied to further enhance the visual quality. Multiple tests were conducted prior to publishing to ensure that the rendering effects were performed smoothly across different devices, and the necessary optimizations were made to improve performance. Actual tests on VR devices were also conducted to verify that the user experience satisfied the expectations, and further optimizations, such as merging meshes and reducing triangle counts, were implemented to enhance performance.

Every element in the scene was optimized to avoid performance issues and lag (Figure 113). Multiple meshes were merged into one using Unity's mesh combine tool, which reduced the number of draw calls. The models were further optimized by removing unnecessary details and reducing the polygon count, which reduced the GPU load. Automatic and manual occlusion culling techniques were used to reduce the number of objects that needed to be rendered, ensuring that invisible objects in the scene were not rendered, which improved the frame rate and overall performance.

Figure 113
Optimization



Source: Screenshot from the author's computer

Objects that were not going to move were marked as static, and Unity's static batching feature was enabled to reduce rendering calls, thereby minimizing the communication between the CPU and GPU. For moving objects, Unity's dynamic batching feature was used to combine rendering calls, and care was taken to avoid using a large number of different materials or meshes, which could reduce batching efficiency. The level of detail (LOD) system was employed for objects viewed from a distance to decrease the polygon count at greater distances, which significantly improved the performance of distant objects.

Low-polygon models were used as substitutes for distant and small objects to reduce the rendering load. In terms of materials and textures, smaller textures and appropriate compression formats were used to reduce memory usage and loading times. The use of too many effects and complex shaders, particularly on mobile devices, was avoided. Performance tests were conducted after each optimization step, and adjustments were made based on the test results to ensure that optimal performance levels were achieved.

After the developers had prepared everything, the VRChat SDK was used to upload the project to the VRChat platform. Before uploading, we must ensure the project complies with VRChat’s regulations, including performance requirements and content guidelines:

a. Performance Optimization: VRChat has strict performance requirements; thus, ensure the project runs smoothly on different devices before uploading. This includes optimizing model polygon count and texture size and using appropriate materials and lighting settings.

b. Content Guidelines: The project complies with VRChat’s content guidelines and does not contain any prohibited material, such as pornography, violence, or racial discrimination. Additionally, ensure that you have legal rights to use or upload all of the content in the project.

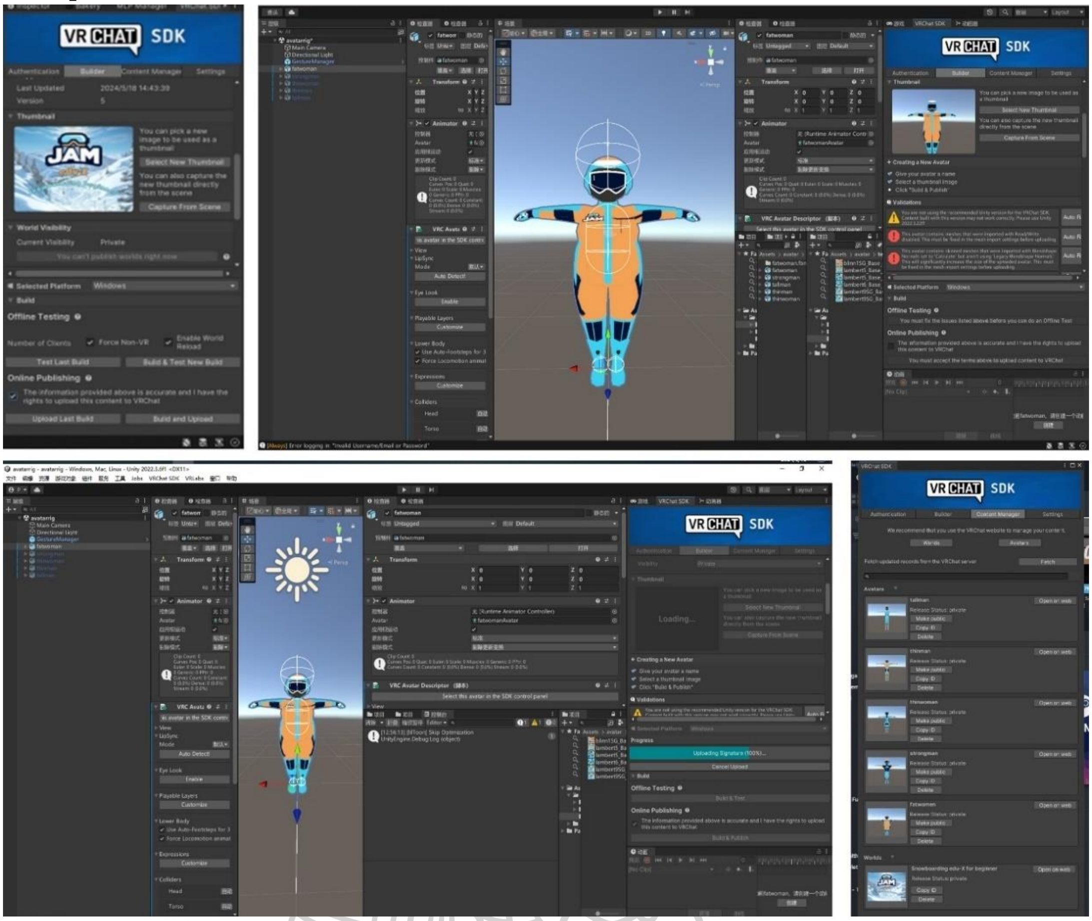
c. User Experience Optimization: This step ensures that the project provides a good user experience on VRChat. This includes correctly setting the player’s initial position and orientation to ensure that they do not spawn outside the map or become embedded in objects.

d. Testing and Debugging: Prior to uploading, perform thorough testing and debugging to ensure there are no significant bugs or issues. This includes testing on different devices to ensure that it runs properly across various configurations.

After completing these preparations, the developers used the VRChat SDK to upload the project to the VRChat platform. First, the developers registered an account on the VRChat website and downloaded and installed the VRChat SDK. Then, they followed the guidelines provided by the SDK to package and upload the project to VRChat (Figure 114).

Figure 114

The Upload Process



Source: Screenshot from the author’s computer

5.7 EXPERT EVALUATION AND OPTIMIZATION

The researchers invited four experts to conduct the evaluation. They were VR, game design, new media, and interaction design experts. The experts assessed the primary model in 10 ways.

1) Realism of the Scene: To what extent does the design of this scene reflect a real snowboarding environment and experience?

2) Interactivity: How many interactive elements are included in the scene to promote player engagement and learning?

3) Educational Value: To what extent does the scene design help players learn and master snowboarding skills?

4) Player Immersion: To what extent can this scene design enhance player immersion and gaming experience?

5) Innovation: How does scene design perform in terms of innovation and creativity?

6) Accessibility: Is the scene easily understandable and accessible for new players while challenging for experienced players?

7) Diversity: Does the scene design offer enough variation and diversity to keep players interested and engaged?

8) Visual and Sound Effects: To what extent does the visual design of a scene enhance the gaming experience?

9) Scalability: Is this scene design easily expandable to include new content, such as new missions, skills, or educational elements?

10) Overall Satisfaction: How satisfied are you with this scene design overall?

Table 9

The Expert Evaluation of the Primary Model

	Nan Lin	*Cheng Yuyan*	*Kevin Ang*	*Takamitsu*	*AVG*
1	4	5	5	4	4.50
2	5	4	5	5	4.75
3	4	4	5	5	4.50
4	4	3	4	4	3.75
5	5	5	5	4	4.75
6	5	4	4	5	4.50
7	3	4	3	4	3.50
8	4	3	5	4	4.00
9	3	5	4	5	4.25
10	5	4	5	5	4.75
Total	42	41	45	45	43.25

Source: Compiled by the author

According to the expert evaluation, the scene design excelled in realism, interactivity, educational value, and innovation (Table 9). The course provided rich interactive elements that effectively helped players learn and master snowboarding skills while demonstrating high levels of innovation. The design was also praised for its accessibility and scalability, meeting the needs of both new and experienced players and allowing for the easy expansion of new content. Although there was room for improvement in player immersion and diversity, the experts were delighted with the scene design. They believed that the system effectively enhanced player engagement and gaming experience.

Experts pointed out that the learning center lacked some decorative elements. This affected the overall visual appeal and might have reduced students' motivation and focus. Appropriate decorative elements create a stimulating and comfortable learning environment. Research has indicated that visual esthetics and environmental comfort significantly affect learning outcomes. Therefore, adding these decorative elements could enhance the space's aesthetics and create a more pleasant and efficient learning atmosphere, enabling students to be more focused and engaged in the learning center. Considering this, it was suggested that more creative decorations should be incorporated into the design to meet different students' needs and enhance their learning experience.

Experts also recommended adding characters with various body types and appearances to increase the diversity and inclusivity of the learning center. This enabled more students to find virtual avatars similar to themselves, enhancing their sense of belonging and promoting understanding and respect for different cultures and individual differences through diverse character designs. Characters with different body types and appearances could reflect diversity in reality, making the learning center more relatable to real life. Additionally, this design could increase user engagement and interest, stimulating their creativity and expression. By introducing diverse characters, the learning center could provide a more comprehensive and enriched educational experience, meeting different students' needs and promoting their growth and development in a diverse environment. All the above comments have been revised in the revised manuscript.

5.8 TESTING AND EVALUATION

5.8.1 OBJECTIVES

1) Testing the Hypothesis

To test whether VR can effectively provide an educational experience for snowboarding beginners. To determine whether it can effectively reduce learning costs and help beginners quickly transition to real-world snowboarding skills.

2) Evaluate User Experience

We evaluated the practical utility and user satisfaction of VR in providing educational snowboarding experiences through participant feedback.

3) Data Collection

The quantitative and qualitative data from the experiments are collected to support the statistical analysis of the experimental results.

4) Analyzing the Experimental Results

Descriptive statistical analysis was used to analyze the collected data to determine the effect of the VR intervention.

5.8.2 EXPERIMENTAL PREPARATION

5.8.2.1 PARTICIPANTS

1) Group 1 (Beginners)

The researchers recruited 15 subjects aged 20–35 with no snowboarding experience. They will receive an educational snowboarding experience through VR. Before participating in the study, the researchers determined whether the participants had any medical conditions that could affect the study. In good health, participants were allowed to participate in the study. The study protocol was revised according to the reviewers’ comments and suggestions (Table 10).

Table 10

General Information of Test Samples

No.	Gender	Age	Education	Occupation
1	Male	30	Bachelor	Engineer
2	Female	31	Master	Manager
3	Male	33	PhD	Fitness Trainer
4	Female	32	Bachelor	Designer
5	Male	34	Master	Engineer
6	Male	27	Bachelor	Developer
7	Male	22	High School	Intern
8	Male	25	Bachelor	Analyst
9	Male	23	High School	Technician
10	Female	23	Bachelor	Designer
11	Female	24	Bachelor	Analyst
12	Female	26	Master	Blogger
13	Female	27	Bachelor	Developer
14	Female	29	PhD	Researcher
15	Female	24	Bachelor	Consultant

Source: Compiled by the author

2) Group 2

Three professionally qualified snowboard instructors. They provided professional evaluation and data comparison and helped verify the accuracy and reliability of the experimental data. The study was simultaneously evaluated.

5.8.2.2 EXPERIMENTAL TOOLS AND EQUIPMENT

1) VR Headsets

Since participants own virtual reality headsets independently, the main VR models are Oculus 2 and HTC. The researcher provides the client with access to the subjects, who can log in remotely to use the system at any time and place.

2) Software or Platform

This study selected VRChat as the platform to design content. Subjects only need to download the platform through a head-mounted display device and enter the experimental entrance provided by the researcher, which is the entrance to the virtual world, to enter the experiment.

3) Recording Equipment

Video camera or mobile phone with camera function. Used to clearly and completely record the entire experimental process for subsequent analysis and quality monitoring.

Time to record the duration of the study.

Notebook to record learning journey. Including the length of device use and frequency of device use.

Paper or electronic questionnaires were used to collect participant data.

4) Snowboard Equipment

Snowboards, snowboard suits, and other equipment used for snowboarding.

5.8.2.3 EXPERIMENTAL SITE AND EXPERIMENTAL TIME

1) Venue 1

Subjects can choose a venue to which they are accustomed according to their daily habits, use VR headsets, and enter the experiment. Or head to the multimedia room provided by the researchers.

2) Venue 2

On-site ski resort. The venue is Beidahu 5A Ski Resort in Jilin, China. This venue has complete track and support facilities. There are separate snowboard trails for beginners. While ensuring the smooth conduct of the test, it also ensures the personal safety of the subjects.

3) Time

Subjects were allowed to use the VR headset at any time during the two weeks they wanted to use it.

5.8.2.4 DATA COLLECTION

The researcher used a questionnaire to collect the results of all experiments. The questionnaire is as follows:

1) Questionnaire used by the participants

2) Pre-test questionnaire

3) Post-test questionnaire

4) Skills-level learning outcomes questionnaire

5) Questionnaires used by the researchers

6) A user behavior observation questionnaire

7) Questionnaire used by snowboard instructors:

8) Experimental evaluation questionnaire

5.8.3 EXPERIMENTAL PROCESS

Phase 1: The researchers arranged samples to experience VR education.

Login and device usage

1) Provide login ports

The researchers provided login ports and usage guides for the VR snowboarding education experience platform to the subjects. After receiving this information, subjects logged into the platform independently.

2) Users can freely choose the place and time of use

Based on early research on user needs, participants could use VR headsets wherever and whenever they felt comfortable. This ensured that subjects participated in the educational experience at their best and improved learning results while meeting the research objectives.

3) Autonomous user learning

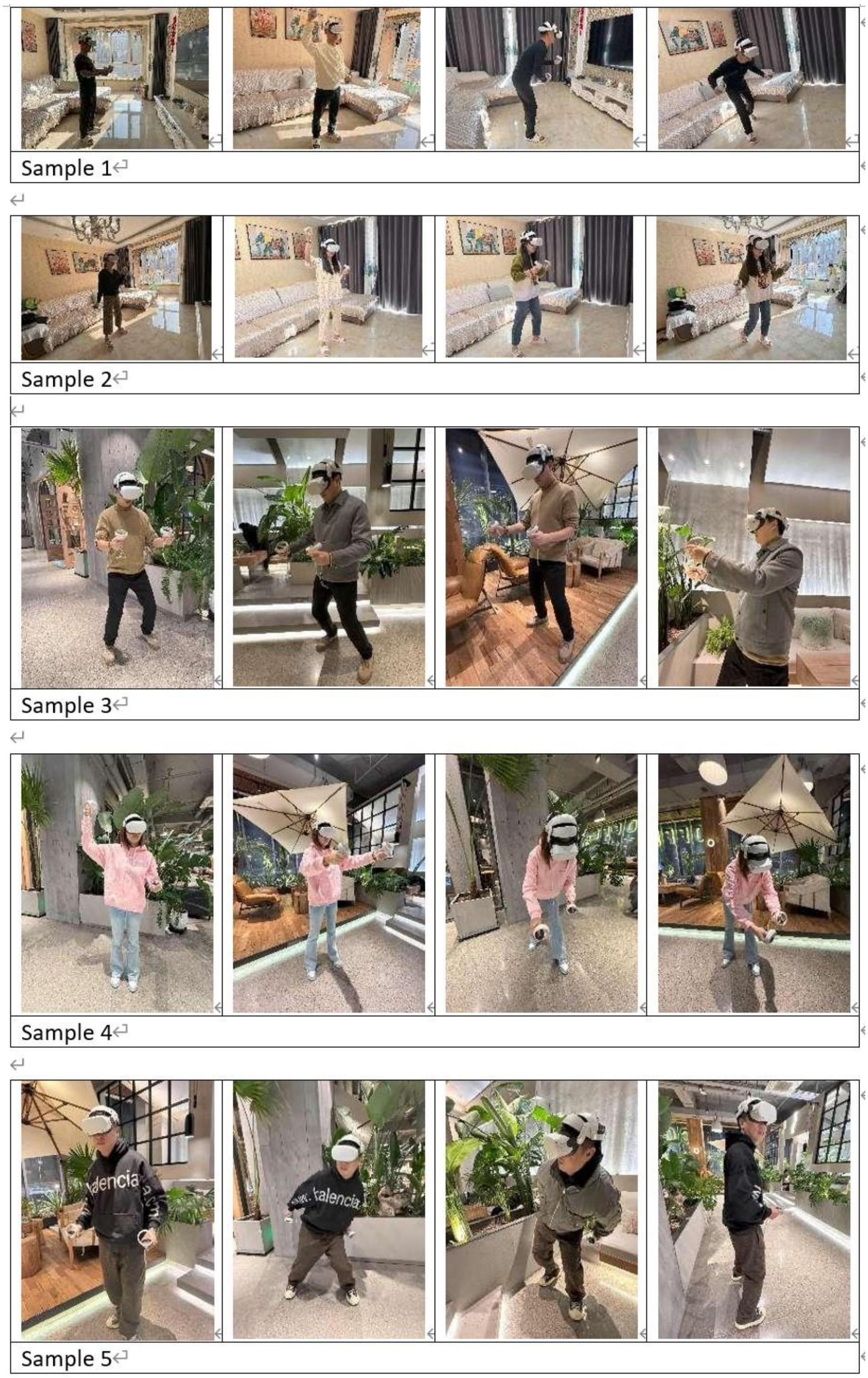
Subjects can repeatedly practice the teaching content in VR according to their learning progress and understanding to ensure they fully master every skill and knowledge point.

4) User behavior observation

The researchers observed the subjects according to their usage status and filled out user behavior observation questionnaires. Due to privacy restrictions on the time and location of the subjects, the researchers entrusted the behavioral observation questionnaires to the subjects' families or friends, who could assist in observing and filling out the questionnaires. Prior to this, the researchers conducted behavioral observation training on the subjects' family members or friends to ensure that they understood how to observe and record the subjects' behaviors to improve the reliability of the data. The following images are test photos provided for the sample (Figures 115 to 117).

Figure 115

Samples 1 to 5



Note. Test photos were provided by the sample.

Source: Compiled by the author

Figure 116
Samples 6 to 10

Sample 6

Sample 7

Sample 8

Sample 9

Sample 10

Note. Test photos were provided by the sample.
Source: Compiled by the author

Figure 117

Samples 11 to 15

Sample 11

Sample 12

Sample 13

Sample 14

Sample 15

Note. Test photos were provided by the sample.

Source: Compiled by the author

Phase 2: After the participants completed the VR education experience, the researchers distributed a pre-test questionnaire to the participants to fill in.

Phase 3: Conduct an educational experience evaluation at a real-life ski resort.

The researchers will arrange for subjects to go to designated real-life ski resorts to conduct actual snowboarding skill assessments. Professional snowboarding instructors score the skill assessment results.

Figure 118

Sample Test in a Ski Resort

Source: Compiled by the author

The assessment is divided into two parts:

The first part is an assessment of theoretical skills. The snowboarding instructors answered the questions based on the questionnaire designed by the researchers and then scored. The snowboarding instructors must observe and question beginners about their mastery of basic skills.

The second part is a test of one's basic snowboarding skills. The snowboarding instructors were asked to observe how long it took the subjects to master their basic snowboarding skills (Figure 132).

Phase 4: The experiment was evaluated by snowboarding instructors.

Phase 5: The researcher collects all assessment results. Perform data analysis.

5.8.4 EXPERIMENTAL RESULTS AND DATA ANALYSIS

5.8.4.1 QUESTIONNAIRE BEFORE USER TESTING

The researchers collected questionnaire results from all the samples. The summary is as follows (Table 11):

Table 11
The Result of the Questionnaire Before User Testing

Sample	*Q1*	*Q2*	*Q3*	*Q4*	*Q5*	*Q6*	*Q7*	*Q8*	*Q9*	*Q10*
S1	1	3	1	4	4	3	4	5	5	4
S2	1	5	1	5	5	4	5	5	5	5
S3	2	4	1	4	4	3	4	4	5	4
S4	1	4	1	4	4	2	5	5	5	4
S5	2	3	1	4	5	3	4	4	4	4
S6	1	2	1	5	4	4	4	4	5	4
S7	1	3	1	4	4	5	4	5	5	5
S8	1	4	1	5	3	4	5	5	5	4
S9	2	4	1	4	4	3	4	5	4	5
S10	1	2	1	3	4	2	5	5	5	4
S11	1	3	1	4	5	3	5	4	5	5
S12	1	4	1	5	4	4	5	5	5	5
S13	2	4	1	4	3	3	4	4	4	4
S14	1	5	1	3	5	2	5	5	4	5
S15	1	3	1	3	4	4	4	4	5	5

Source: Compiled by the author

Q1. How familiar are you with snowboarding?

(1 - Not familiar at all, 5 - Very familiar)

Q2. How familiar are you with virtual reality?

(1 - Not familiar at all, 5 - Very familiar)

Q3. Have you received any previous snowboarding training or education?

(1 - Never received, 5 - Received many times)

Q4. What are your expectations when using virtual reality for snowboarding training?

(1 - No expectations at all, 5 - High expectations)

Q5. How much do you think VR can help with snowboarding education?

(1 - No help at all, 5 - Great help)

Q6. How would you rate your expected difficulty level for this virtual reality snowboarding education experience?

(1 - Very difficult, 5 - Very easy)

Q7. Do you believe that this virtual reality experience will increase your interest in snowboarding?

(1 - Completely disagree, 5 - Strongly agree)

Q8. Can this virtual reality experience improve your confidence in snowboarding?

(1 - Completely disagree, 5 - Strongly agree)

Q9. How much do you expect from this experience?

(1 - Not expecting at all, 5 - Expecting a lot)

Q10. Do you anticipate an increased understanding of snowboarding through this virtual reality experience?

(1 - Not expecting at all, 5 - Expecting a lot)

The researchers analyzed the results of the data and found the following (Table 12):

Table 12

Analysis of Questionnaire Before User Testing

Question	***AVG***	***MEDIAN***	***SD***
Q1	1.27	1.00	0.46
Q2	3.53	4.00	0.92
Q3	1.00	1.00	0.00
Q4	4.07	4.00	0.70
Q5	4.13	4.00	4.00
Q6	3.27	3.27	0.88
Q7	4.47	4.00	0.52
Q8	0.52	5.00	5.00
Q9	4.73	5.00	0.46
Q10	4.47	4.00	0.52

Source: Compiled by the author

Q1: How familiar are you with snowboarding?

Most participants reported a very low level of familiarity with snowboarding. The mean score was approximately 1, and the median was 1, indicating that participants had almost no experience with snowboarding. The standard deviation is small (0.46), suggesting that most participants' familiarity is concentrated at a very low level.

Q2: How familiar are you with virtual reality?

Participants were moderately familiar with VR. The mean score was 3.53, and the median was 4, indicating that most participants understood VR but were not completely familiar with it. The standard deviation is 0.92, indicating some variation in familiarity among the participants.

Q3: Have you received any previous snowboarding training or education?

None of the participants received any training or education in snowboarding. The mean and median scores are 1, and the standard deviation is 0, indicating uniformity of the data.

Q4: What are your expectations for virtual reality-based snowboarding training?

Participants had high expectations for using VR in their snowboarding training. The mean score was 4.07, and the median was 4, indicating positive expectations for this teaching method. The standard deviation is 0.70, indicating that the expectations are relatively concentrated.

Q5: How much do you think VR can help with snowboarding education?

Participants also believed that VR could significantly aid snowboarding education. The mean score was 4.13, and the median was 4, indicating a positive attitude toward applying this technology in education. The standard deviation is 0.64, indicating relative consistency in the participants' views.

Q6: How would you rate your expected difficulty level for this virtual reality snowboarding education experience?

Participants expected the difficulty level of the VR education experience to be moderate. The mean score was 3.27, and the median was 3, indicating moderate expectations regarding the difficulty of the experience. The standard deviation is 0.88, indicating some variation in expected difficulty among participants.

Q7: Do you believe that this virtual reality experience will increase your interest in snowboarding?

Most participants believed that VR experiences enhanced their interest in snowboarding. The mean score was 4.47, and the median was 4, indicating a positive attitude toward the teaching method. The standard deviation is 0.52, indicating relative consistency in the participants' views.

Q8: Can this virtual reality experience improve your confidence in snowboarding?

The majority of participants believed that the VR experience could boost their confidence in snowboarding. The mean score was 4.60, and the median was 5, indicating a positive attitude toward the teaching method. The standard deviation is 0.51, indicating relative consistency in the participants' views.

Q9: How much do you expect from this experience?

Participants have very high expectations for this experience. The mean score was 4.73, and the median was 5, indicating high expectations for this teaching method. The standard deviation is 0.46, suggesting that the participants' expectations were relatively concentrated.

Q10: Do you anticipate an increased understanding of snowboarding after you complete this virtual reality experience?

Most participants expected an increased understanding of snowboarding through VR experiences. The mean score was 4.47, and the median was 4, indicating a positive attitude toward the teaching method. The standard deviation is 0.52, indicating relative consistency in the participants' views.

Summary of Descriptive Statistics

1) Participant Background: Most participants were beginner snowboarders with a moderate understanding of VR.

2) Expectations and Attitudes: Participants had high expectations for the VR teaching method and believed it would significantly aid snowboarding education.

3) Interest and Confidence: Participants believed that the VR experience enhanced their interest and confidence in snowboarding, indicating the potential motivational effect of this teaching method.

4) Expected Difficulty: Participants expected the difficulty level of the VR education experience to be moderate, indicating adaptability to this novel teaching method.

5.8.4.2 THE USER OBSERVATION

The researchers collected questionnaire results from all the samples. The results are summarized as follows (Table 13).

Table 13

The Result of the User Observations

Sample	*Q1*	*Q2*	*Q3*	*Q4*	*Q5*
S1	5	5	4	4	4
S2	4	5	5	3	4
S3	5	5	4	3	4
S4	5	5	4	4	3
S5	5	4	3	5	4
S6	4	4	3	4	4
S7	4	4	4	4	5
S8	5	5	5	3	4
S9	4	5	4	3	4
S10	5	5	5	5	3
S11	4	5	4	5	4
S12	5	4	4	4	5
S13	5	5	3	5	4
S14	5	5	4	3	4
S15	4	5	4	4	4

Source: Compiled by the author

1) Audience Interest in the VR Experience Project

Rating Scale: 1 (Not Interested at All) to 5 (Very Interested)

2) Audience Excitement When Picking Up VR Equipment

Rating Scale: 1 (Not Excited at All) to 5 (Very Excited)

3) Audience Comfort Level During the Experience

Rating Scale: 1 (Very Uncomfortable) to 5 (Very Comfortable)

4) Appropriate Duration of VR Experience

Rating Scale: 1 (Completely Inappropriate) to 5 (Very Appropriate)

5) Audience Success Rate in Completing the Experience

Rating Scale: 1 (Not Successful at All) to 5 (Very Successful)

The researchers analyzed the results of the data and found the following (Table 14):

Table 14
The Analysis of the User Observations

Question	*AVG*	*MEDIAN*	*SD*
Q1	4.60	5.00	0.51
Q2	4.73	5.00	0.46
Q3	4.00	4.00	0.65
Q4	3.93	4.00	0.80
Q5	4.00	4.00	0.53

Source: Compiled by the author

Q1: Audience Interest in the VR Experience Project

Most audience members were highly interested in the VR experience project. The mean score was close to 5, and the median was 5, indicating that most of the audience was very interested in the project. The low standard deviation suggests a consistent level of interest among the audiences.

Q2: Audience Excitement When Picking Up VR Equipment

The audience showed high excitement when picking up the VR equipment. The mean and median scores were close to 5, indicating the audience's excitement about the equipment. The small standard deviation indicates that the level of excitement was relatively consistent among the audience.

Q3: Audience Comfort Level During the Experience

The audience generally felt comfortable during the experience. The mean and median scores were 4, indicating that most of the audience felt comfortable. The moderate standard deviation indicates some variation in the comfort levels among the audience.

Q4: Appropriate Duration of VR Experience

The audiences generally considered the duration of the experience appropriate. The mean score was close to 4, and the median was 4, indicating that most of the audience found the duration suitable. The slightly higher standard deviation suggests some disagreement among the audience about the appropriateness of the duration.

Q5: Audience Success Rate in Completing Experience

The audience demonstrated a high success rate in completing the experience. The mean and median scores were 4, indicating that most of the audience completed the experience. The small standard deviation indicates the audience's success rate is relatively consistent.

Summary of Descriptive Statistics

1) Most audience members expressed high interest and excitement in the VR experience project.

2) The audience felt comfortable during the experience and considered the duration appropriate.

3) The audience demonstrated a high success rate in completing the experience.

5.8.4.3 POST-USER TEST QUESTIONNAIRE

The researchers collected questionnaire results from all the samples. The summary is as follows (Table 15):

Table 15

The Results of the Post-User Test Questionnaire

Sample	*Q1*	*Q2*	*Q3*	*Q4*	*Q5*	*Q6*	*Q7*	*Q8*	*Q9*	*Q10*
S1	4	4	4	5	4	5	4	5	4	4
S2	4	4	5	4	3	5	5	4	5	4
S3	3	5	5	4	4	5	5	4	4	4
S4	4	4	5	5	5	5	5	4	5	4
S5	4	3	4	4	4	4	4	5	5	5
S6	5	4	5	5	4	5	5	4	5	4
S7	4	5	4	5	3	4	5	5	5	5
S8	4	4	4	5	4	4	5	5	5	4
S9	4	4	4	4	5	5	4	4	4	4
S10	3	3	5	5	4	4	5	5	5	5
S11	3	4	4	4	3	4	4	4	4	4
S12	4	4	3	5	4	3	5	5	5	4
S13	4	4	4	5	5	4	5	4	4	4
S14	3	4	4	4	4	4	5	5	5	5
S15	4	5	4	5	4	4	5	4	4	4

Source: Compiled by the author

Q1. Has virtual reality replaced traditional teaching tools in the snowboarding learning process?

1 - Not replaced at all, 5 - Completely replaced

Q2. Does learning with virtual reality provide interaction and feedback opportunities that you have never experienced before?

1 - No opportunities provided, 5 - Many opportunities provided

Q3. Has this technology changed your learning method, making the learning process more efficient?

1 - No change at all, 5 - Greatly changed

Q4. Does virtual reality allow you to perform learning activities that are not possible with traditional teaching methods?

1 - Not at all, 5 - Fully possible

Q5. Do you think virtual reality technology has completely redefined the way in which snowboarding is learned?

1 - Completely disagree, 5 - Completely agree

Q6. Are you satisfied with your overall experience of learning snowboarding using virtual reality?

1 - Completely dissatisfied, 5 - Very satisfied

Q7. How much has your understanding of snowboarding improved through virtual reality teaching?

1 - No improvement, 5 - Great improvement

Q8. After completing this course, have you applied the newly learned skills to actual snowboarding activities?

1 - Not applied at all, 5 - Fully applied

Q9. Has this teaching method increased your interest in continuing to learn and practice snowboarding?

1 - No increase at all, 5 - Great increase

Q10. Do you think this teaching method has been effective in improving your snowboarding skills?

1 - Not effective, 5 - Very effective

The researchers analyzed the results of the data and found the following (Table 16):

Table 16

The Analysis of Post-User Test Questionnaire

Question	***AVG***	***MEDIAN***	***SD***
Q1	3.80	4.00	0.56
Q2	4.07	4.00	0.59
Q3	4.27	4.00	0.59
Q4	4.60	5.00	0.51
Q5	4.00	4.00	0.65
Q6	4.33	4.00	0.62
Q7	4.73	5.00	0.46
Q8	4.47	4.00	0.52
Q9	4.60	5.00	0.51
Q10	4.27	4.00	0.46

Source: Compiled by the author

SAMR MODEL ANALYSIS

1) Substitution Level

Effectiveness of VR as Substitute for Traditional Teaching Tools. Participants also believed that VR could partially substitute traditional teaching tools. Most scores were concentrated at 4, indicating some success in substitution but not a complete replacement.

2) Augmentation Level

Enhancement of Learning Interaction and Feedback. Participants believe that VR provides new opportunities for interaction and feedback that they have not experienced before. The scores were high and were concentrated at 4, indicating good performance in enhancing learning interactions and feedback.

3) Modification Level

Transformation of Learning Methods and Improvement of Learning Efficiency.

Participants believed that VR technology has changed their learning methods and improved learning efficiency. The scores were high, indicating positive effects on modifying the learning methods.

4) Redefinition Level

The Ability of VR to Enable New Learning Activities. Participants generally believed that VR enabled impossible learning activities with traditional teaching. The scores were very high, indicating significant potential for redefining learning activities.

5) Redefining Snowboarding Learning Methods Using VR Technology

Participants also believed that VR had somewhat redefined snowboarding learning methods. Scores are concentrated at 4, indicating significant effects but room for improvement.

KIRKPATRICK MODEL ANALYSIS

6) Reaction Level

Overall Satisfaction with the Virtual Reality Snowboarding Learning Experience.

Participants were satisfied with their overall experience of using VR for snowboarding learning. High scores indicate a positive attitude toward the learning experience.

7) Learning Level

Improvement in Understanding Snowboarding through VR Teaching.

Participants also believed that VR teaching greatly improved their understanding of snowboarding. Scores are very high and concentrated at 5, indicating significant effectiveness in enhancing learning comprehension.

8) Behavior Level

Application of Newly Learned Skills to Actual Snowboarding Activities. Most participants believed they had applied their newly learned skills to snowboarding activities. High scores indicate a positive impact on skill application.

Increased Interest in Continuing to Learn and Practice Snowboarding. Participants expressed that the VR teaching method increased their interest in continuing to learn and practice snowboarding. Scores were very high, indicating significant effectiveness in stimulating learning interest.

9) Results Level

Effectiveness of VR Teaching in Improving Snowboarding Skills. Participants also believed that the VR teaching method improved their snowboarding skills. High scores indicate significant skill enhancement.

SUMMARY OF DESCRIPTIVE STATISTICS

Combining the results of the SAMR and Kirkpatrick Model Evaluations, the participants expressed a positive attitude toward applying VR in snowboarding learning.

1) SAMR Model Analysis Summary

Substitution Level: VR can partially substitute traditional teaching tools, with scores concentrated at 4, indicating some success.

Augmentation Level: VR enhances interaction and feedback, with high scores of 4 indicating significant effectiveness.

Modification Level: VR technology transforms learning methods and improves learning efficiency, with high scores indicating positive effects.

Redefinition Level: VR has great potential for redefining learning activities and enabling new activities that are impossible with traditional teaching.

2) Kirkpatrick Model Analysis Summary

Reaction Level: Participants were satisfied with the VR snowboarding learning experience, with high scores indicating positive experiences.

Learning Level: Participants reported that their understanding of snowboarding had significantly improved through VR teaching, with scores of 5.

Behavior Level: Participants applied newly learned skills to actual snowboarding activities, with high scores indicating good skill application. The VR teaching method also significantly stimulated interest in continuing to learn and practice snowboarding.

Results Level: Participants believed that VR teaching effectively improved their snowboarding skills, with high scores indicating significant effectiveness.

5.8.4.4 SKILL TEST

THEORETICAL QUESTION AND ANSWER SCORES

The researchers collected questionnaire results from all the samples. The summary is as follows (Table 17):

Table 17

The Result of Scores of Theoretical Questions and Answers

Sample	*Q1*	*Q2*	*Q3*	*Q4*	*Q5*	*Q6*	*Q7*	*Q8*	*Q9*	*Q10*
S1	5	5	5	5	5	5	5	4	4	4
S2	5	5	5	4	4	5	4	4	4	5
S3	4	4	5	5	4	4	5	4	5	4
S4	5	4	5	4	5	5	5	5	5	4
S5	5	5	4	5	5	5	5	4	5	4
S6	5	5	5	4	5	5	5	5	3	5
S7	4	5	5	4	4	4	4	5	4	5
S8	5	5	5	4	5	5	5	5	5	5
S9	4	5	5	4	4	5	5	5	5	4
S10	4	4	5	3	5	5	5	4	4	5
S11	5	5	4	5	5	5	4	5	4	4
S12	5	5	5	5	4	5	5	5	3	5
S13	5	5	5	4	5	4	5	4	4	4
S14	4	5	5	5	4	5	4	3	4	5
S15	5	5	4	4	5	4	5	5	5	4

Source: Compiled by the author

Skill in Snowboarding Skills

1) Determine the correct stance for snowboarding.

2) Should beginners properly start and stop snowboarding.

3) Determine how to choose the lead foot (Dominant Foot).

4) How to select an appropriate slope based on skill level.

5) Explain how to properly wear and use snowboarding equipment.

Knowledge of Snowboarding Safety

6) Equipment Inspection: What safety equipment checks should be conducted Before Starting Snowboarding?

7) Avoiding Collisions: What methods can be used to avoid collisions with other snowboarders under crowded conditions?

8) Fall Handling: What measures should be taken to minimize injury risk in falls?

9) Emergency situations: Should one seek help during an emergency?

10) Environmental Awareness: Why is understanding weather and snow conditions important? How does this affect snowboarding safety?

The researchers analyzed the results of the data and found the following (Table 18):

Table 18

The Analysis of Scores of Theoretical Questions and Answers

Question	***AVG***	***MEDIAN***	***SD***
Q1	4.73	5.00	0.46
Q2	4.87	5.00	0.35
Q3	4.87	5.00	0.35
Q4	4.40	4.00	0.51
Q5	4.60	5.00	0.51
Q6	4.80	5.00	0.41
Q7	4.67	5.00	0.49
Q8	4.60	5.00	0.51
Q9	4.33	4.00	0.62
Q10	4.60	5.00	0.51

Source: Compiled by the author

Knowledge of Snowboarding Skills

1) Correct Stance Mastery: Participants generally demonstrated high proficiency in maintaining the correct stance and achieved high scores. This indicates the significant effectiveness of VR instruction in this area. Compared to traditional teaching methods, VR provides a more intuitive demonstration of the correct stance, thus enhancing learning outcomes.

2) Initiation and Stopping Skills: Participants excelled at starting and stopping snowboarding and received high scores.

3) Dominant Foot Selection: Participants demonstrated a good understanding of selecting the dominant foot with high scores. VR instruction provides intuitive guidance to help learners better comprehend and apply the knowledge they have acquired.

4) Slope Selection: While participants were proficient in choosing appropriate slopes, their scores were slightly lower than those of other skills. VR teaching can simulate different slopes, assisting learners in making better slope selections than traditional methods.

5) Snowboarding Equipment Use: Participants exhibited good proficiency in wearing and using snowboarding equipment, achieving high scores. VR instruction offers detailed operational demonstrations to help learners better grasp equipment usage techniques.

Knowledge of Snowboarding Safety

6) Equipment Inspection Knowledge: Participants exhibited excellent knowledge of equipment inspection and received very high scores. VR teaching provides comprehensive guidance on safety equipment inspections and enhances learners' safety awareness.

7) Collision Avoidance: Participants with high scores had good knowledge of collision avoidance. VR teaching can simulate various scenarios and help learners handle real-life situations better than traditional methods.

8) Fall Management: Participants demonstrated good knowledge of fall management, with high scores. VR instruction offers detailed fall handling guidance, improving learners' ability to manage falls safely.

9) Emergency Situations: Although participants showed good knowledge of handling emergencies, their scores were slightly lower than those of the other safety areas. VR teaching can simulate emergencies and enhance learners' emergency handling skills.

10) Environmental Awareness: Participants had good knowledge of environmental awareness and achieved high scores. VR instruction provides detailed explanations of environmental factors and improves learners' environmental consciousness.

Comparison with Traditional Snowboarding Teaching Methods for Beginners

Researchers interviewed snowboarding instructors to compare traditional teaching data with the study results. The instructors noted that in traditional teaching, beginners typically scored around 1 point on these topics, with higher scores only for those with prior experience in sports like snowboarding or surfing. The scores achieved by the participants in this study strongly indicate the effectiveness of the VR educational experience. Compared to traditional snowboarding beginner teaching methods, VR instruction excels in the following aspects:

1) Intuitiveness and Interactivity: VR teaching offers more intuitive content and interactive opportunities to help learners better understand and master skills.

2) Simulation of Real Scenarios: VR teaching can simulate different snowboarding scenarios and environmental conditions, allowing learners to gain experience in a virtual environment and improve their ability to handle real-life situations.

3) Feedback and Guidance: VR teaching provides real-time feedback and guidance to help learners correct mistakes promptly and enhance learning outcomes.

4) Safety: VR teaching offers comprehensive safety knowledge and guidance, improving learners' safety awareness and handling skills.

SCORE FOR PRACTICAL SKILLS

The researchers collected questionnaire results from all experts. The summary is as follows (Table 19).

Table 19

The Results of Practical Skills

Sample	*Q1*	*Q2*	*Q3*	*Q4*	*Q5*	*Q6*	*Q7*	*Q8*	*Q9*	*Q10*
S1	4	4	5	4	5	5	4	4	5	5
S2	4	4	4	4	3	3	4	3	3	4
S3	3	4	4	4	4	4	4	3	4	4
S4	4	4	3	3	4	3	4	4	4	3
S5	3	4	4	4	4	4	4	4	4	4
S6	3	3	3	4	3	3	3	4	3	4
S7	4	5	4	5	5	5	5	4	5	5
S8	5	4	4	4	5	5	5	4	5	5
S9	5	4	4	4	5	5	4	5	4	5
S10	4	4	4	4	5	5	4	5	4	5
S11	3	4	3	3	4	3	4	4	3	4
S12	4	4	4	4	4	4	4	4	4	4
S13	4	3	4	4	3	4	4	3	4	4
S14	5	4	4	4	3	4	3	4	3	4
S15	5	4	4	4	5	5	4	5	4	5

Source: Compiled by the author

Scoring Criteria Definition (Based on Mastery Speed)

1) Very Slow (1 point): Participants demonstrated a very slow speed in mastering the skill, requiring a long time to grasp it partially.

2) Slow (2 points): Participants showed a slow speed in mastering the skill, needing considerable time to achieve basic proficiency.

3) Average (3 points): Participants exhibited an average speed in mastering the skill, achieving basic proficiency within an appropriate timeframe.

4) Fast (4 points): Participants demonstrated a fast mastery of the skill, achieving good proficiency in a relatively short time.

5) Very Fast (5 points): Participants showed a fast mastery of the skill, achieving complete proficiency quickly.

SNOWBOARDING TECHNICAL MOVEMENTS

1) Initiation

2) Stopping

3) Back Edge Straight Line Push

4) Back Edge Left Slide

5) Back Edge Right Slide

6) Back Edge Falling Leaf

7) Front Edge Straight Line Push

8) Front Edge Left Slide

9) Front Edge Right Slide

10) Front Edge Falling Leaf

The researchers analyzed the results of the data and found the following (Table 20):

Table 20

The Analysis of Practical Skills

Question	***AVG***	***MEDIAN***	***SD***
Q1	4.00	4.00	0.76
Q2	3.93	4.00	0.46
Q3	3.87	4.00	0.52
Q4	3.93	4.00	0.46
Q5	4.13	4.00	0.83
Q6	4.13	4.00	0.83
Q7	4.00	4.00	0.53
Q8	4.00	4.00	0.65
Q9	3.93	4.00	0.70
Q10	4.33	4.00	0.62

Source: Compiled by the author

Mastery Speed of Snowboarding Skills

1) Initiation Skills: Participants demonstrated a relatively fast mastery of initiation skills, with overall good performance. Scores were concentrated at approximately 4, with a slightly high standard deviation, indicating participant mastery speed variability.

2) Stopping Skill: Participants showed a relatively fast mastery of stopping skills, with overall good performance. Scores were concentrated at approximately 4, with a small standard deviation, indicating consistent mastery speed among most participants.

3) Back Edge Straight Line Push: Participants exhibited an average speed in mastering the back edge straight line push, with overall good performance. Scores were close to 4, with a small standard deviation, indicating similar mastery speeds among most participants.

4) Back Edge Left Slide: Participants demonstrated a relatively fast mastery of the back edge left slide, with overall good performance. Scores were concentrated at

approximately 4, with a small standard deviation, indicating consistent mastery speed among most participants.

5) Back Edge Right Slide: Participants showed a relatively fast speed in mastering the back edge right slide, with overall good performance. Scores slightly above 4 with a high standard deviation indicate participant mastery speed variability.

6) Back Edge Falling Leaf: Participants exhibited a relatively fast speed in mastering the back edge falling leaf, with overall good performance. Scores slightly above 4 with a high standard deviation indicate participant mastery speed variability.

7) Front Edge Straight Line Push: Participants demonstrated a relatively fast mastery of the front edge straight line push, with overall good performance. Scores were concentrated at approximately 4, with a small standard deviation, indicating consistent mastery speed among most participants.

8) Front Edge Left Slide: Participants showed a relatively fast speed in mastering the front edge left slide, with overall good performance. Scores were concentrated at approximately 4, with a slightly high standard deviation, indicating some participant mastery speed variability.

9) Front Edge Right Slide: Participants exhibited a relatively fast mastery of the front edge right slide, with overall good performance. Scores were close to 4, with a high standard deviation indicating participant mastery speed variability.

10) Front Edge Falling Leaf: Participants demonstrated a relatively fast speed in mastering the front edge falling leaf, with good performance—scores slightly above 4 and moderate standard deviation, indicating similar mastery speeds among most participants.

Comparison with Traditional Snowboarding Teaching Methods for Beginners

Compared to traditional teaching methods for beginner snowboarders, VR instruction excels in the following aspects:

1) Mastery Speed: VR instruction enabled participants to master various snowboarding skills quickly, with generally high scores indicating high teaching efficiency.

2) Consistency: The relatively small standard deviations in scores indicate consistent mastery speeds among most participants, suggesting that VR instruction provides stable learning outcomes.

3) Skill Diversity: VR instruction covered various skills, including initiation, stopping, turning, pushing, and falling leaf maneuvers, to comprehensively enhance participants' snowboarding abilities.

Overall, VR teaching methods outperform traditional teaching methods in terms of the effectiveness of teaching snowboarding skills, providing beginners with a more efficient and comprehensive learning experience.

5.8.4.5 QUESTIONNAIRE FOR SNOWBOARDING INSTRUCTORS' EVALUATION OF VIRTUAL REALITY EDUCATION EXPERIENCE FOR SNOWBOARDING BEGINNERS

The researchers collected questionnaire results from all experts. The results are summarized as follows (Table 21).

Table 21

The Result of the Experts' Evaluation

Sample	*Q1*	*Q2*	*Q3*	*Q4*	*Q5*	*Q6*	*Q7*	*Q8*	*Q9*	*Q10*
S1	4	5	4	5	4	4	3	4	5	3
S2	5	5	4	5	4	3	3	4	4	4
S3	5	5	4	5	4	4	4	5	5	5

Source: Compiled by the author

1) Effectiveness of Teaching Method:

How effective is this virtual reality teaching method for learners attempting to master snowboarding skills?

- Results Level (1 - Not effective at all, 5 - Very effective)

2) Participants' Learning Outcomes:

How much do you think participants' skills and knowledge have improved through virtual reality learning?

- Learning Level (1 - No improvement, 5 - Great improvement)

3) Participants' Behavior Change:

How well did the participants apply the newly learned skills to actual snowboarding?

- Behavior Level (1 - Not applied at all, 5 - Fully applied)

4) Satisfaction with Teaching Content:

How satisfied are you with the educational content used in virtual reality teaching?

- Reaction Level (1 - Very dissatisfied, 5 - Very satisfied)

5) Comfort of Learning Environment:

How comfortable are learners' learning environments provided by virtual reality?

- Reaction Level (1 - Very uncomfortable, 5 - Very comfortable)

6) Durability of Learning Outcomes:

Do you think skill improvements from virtual reality teaching are temporary or long-lasting?

- Results Level (1 - Just a temporary improvement, 5 - Significantly long-lasting improvement)

Data Analysis: Based on the SAMR Model

7) Level of Technology Application:

How do you think virtual reality technology functions in teaching? Does it replace traditional teaching tools or completely change teaching methods?

- Redefinition Level (1 - Just replaces, 5 - Completely changes)

8) Enhancing Teaching Interactions:

Does virtual reality technology increase learners' interaction and engagement?

- Augmentation Level (1 - No increase, 5 - Great increase)

9) Depth of Technology Integration:

How do you think virtual reality technology can be integrated into snowboarding teaching? Does it provide new learning resources and methods?

- Modification Level (1 - No new resources provided, 5 - Provides many new resources and methods)

10) Impact of Technology on Teaching Strategies:

Do you think virtual reality technology is changing traditional teaching strategies and methods?

- Redefinition Level (1 - No change at all, 5 - Completely changes)

Data Analysis: Based on the Kirkpatrick Model

1) Effectiveness of Teaching Method: Snowboarding instructors rated the VR teaching method as highly effective for mastering snowboarding skills, with scores of 5 indicating excellent effectiveness.

2) Participants' Learning Outcomes: All the snowboarding instructors agreed that the participants' skills and knowledge were significantly improved after learning through VR. Scores were consistently 5, indicating remarkable learning outcomes.

3) Participants' Behavior Change: Instructors observed that participants effectively applied newly learned skills to actual snowboarding, with consistent scores of 4, suggesting a positive impact of VR teaching on behavior change.

4) Satisfaction with Teaching Content: Instructors were highly satisfied with the educational content used in VR teaching, with a consistent score of 5 indicating high-quality teaching content.

5) Comfort of Learning Environment: Instructors found the learning environment provided by VR to be quite comfortable, with consistent scores of 4, indicating a good level of comfort.

6) Durability of Learning Outcomes: Instructors believed that the skills acquired through VR teaching had a relatively lasting effect, but there is room for improvement. Scores were close to 4, indicating good durability.

Based on the SAMR Model

7) Level of Technology Application: Instructors felt that VR technology mainly substituted traditional teaching tools, with scores concentrated at 3, suggesting room for improvement by completely transforming teaching methods.

8) Enhancement of Teaching Interaction: Instructors noted increased learner interaction and engagement due to the VR technology, with consistent scores of 4 indicating enhanced interactivity.

9) Depth of Technology Integration: Instructors believed that VR technology was deeply integrated into snowboarding teaching, providing new learning resources and methods. Scores were high, indicating effective technology integration.

10) Impact of VR Technology on Teaching Strategies: Instructors had mixed opinions on the extent of VR technology's impact on teaching strategies. Some individuals observed a significant change, while others were more reserved. Scores were relatively high but varied.

Combining the evaluations based on the Kirkpatrick and SAMR Models, it is evident that VR technology has numerous advantages in snowboarding education:

The VR teaching method demonstrated outstanding performance in enhancing learners' skills, knowledge, behavioral changes, and satisfaction with the instructional content. The learning outcomes are significant, the learning environment is comfortable, and the effects are long-lasting. VR technology has replaced traditional tools, enhanced interactivity, deeply integrated new resources and methods, and significantly impacted teaching strategies. Based on the data analysis results and the final opinions of expert evaluations, this study has effectively reduced learning costs for snowboarding beginners, allowing them to quickly transition to real-world snowboarding skills and promoting the inheritance and development of winter sports culture. These findings strongly support the application of VR in snowboarding education, indicating its vast potential and promising future in improving learning outcomes, enhancing learning experiences, and innovating teaching methods.

5.9 CHAPTER SUMMARY

This chapter details the comprehensive design, development, testing, and evaluation of a VR educational experience for snowboarding beginners. The design phase focused on creating robust information architecture and realistic environments, including terrains, learning centers, and interactive facilities. Character designs and the VRChat platform allowed us to leverage existing resources to create innovative content. Rigorous testing ensured the functionality and effectiveness of the educational content, and user feedback refined the designs to ensure a seamless experience.

Comprehensive evaluations also validated the success of VR in the educational experience of snowboarding beginners. It can effectively reduce learning costs for beginners, increase engagement, and help them quickly transition to real-world snowboarding skills. The proposed method has received unanimous praise from users, experts, and instructors.

CHAPTER 6 CONCLUSION

DISCUSSION AND RECOMMENDATION

6.1 CONCLUSION

This chapter discusses the results corresponding to the three research objectives in detail, leading to several key findings. These findings not only validate the hypotheses but reveal new insights. Additionally, the researchers compared these findings with previous studies and theories, summarizing the similarities and differences. Toward the end of the chapter, the researchers outline the study's limitations and suggest directions for future development. The aim of this review is to provide strategies for further optimizing current practices, advancing the field, and offering valuable references for future work.

6.1.1 EDUCATION EXPERIENCE NEEDS OF SNOWBOARDING BEGINNERS

Through extensive literature reviews, comprehensive surveys, multi-faceted field observations, and in-depth interviews, the researchers have gradually clarified the specific content of educational experiences for snowboarding beginners.

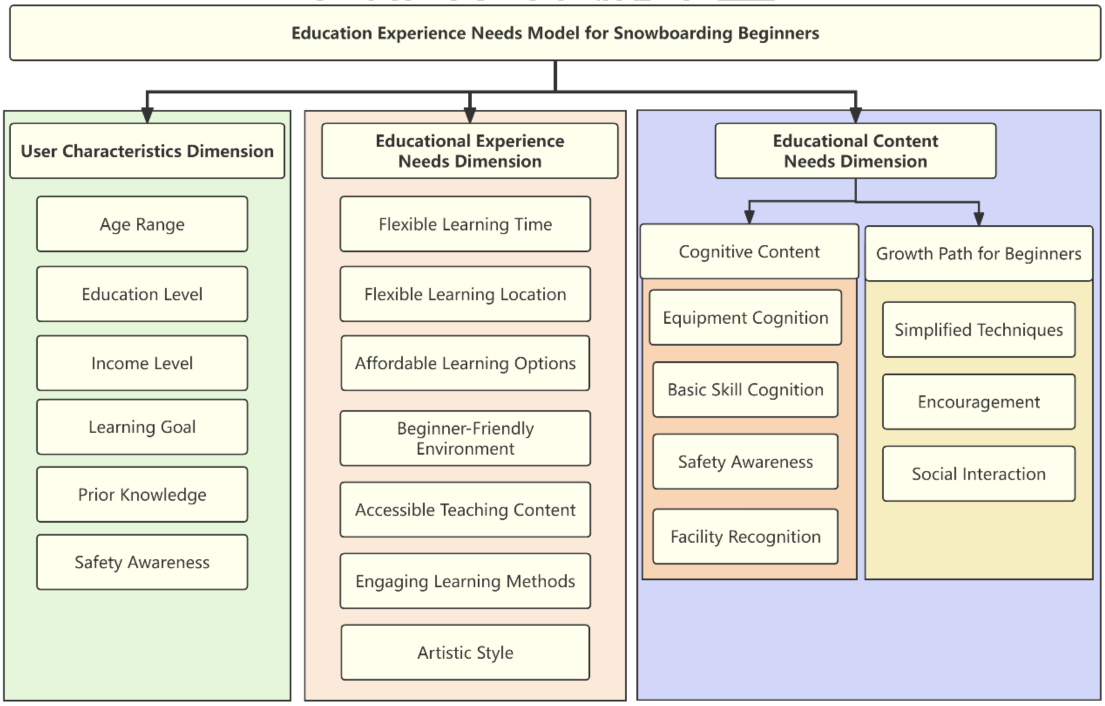
According to the researchers' investigations, most of the enthusiast group consists of Millennials and Generation Z. Millennials are influenced by digitalization and social media, and they enjoy sharing and showcasing their lifestyles and hobbies through social media. As an extreme sport, snowboarding offers many fantastic and thrilling moments, making it particularly suitable for photo and video sharing, which appeals to Millennials. They also focus on health and exercise. Snowboarding is a fun sport and a way to exercise the body and improve fitness and coordination, which is aligned with the pursuit of a healthy lifestyle. Additionally, they like to try new things and seek unique experiences. As a challenging sport, snowboarding provides the excitement and sense of accomplishment they crave.

Growing up in a highly technological environment, Generation Z is familiar with and interested in emerging technologies, such as virtual reality (VR) and augmented reality (AR). Their pursuit of diversity and personalization, as well as their emphasis on social interaction and community awareness, make them value social interaction and a sense of community. As a social sport, snowboarding allows people to meet like-minded friends at ski resorts and clubs, enhancing their social connections.

This young group not only accepts higher education but is also intensely interested in new technological products. However, they are also at the busiest stage, facing multiple pressures from studies, work, starting families, and raising children. These responsibilities take up most of their time, energy, and financial resources. As is well known, snowboarding, a winter extreme sport, requires substantial financial support and time investment, making it difficult for people to enjoy the fun it brings quickly. Therefore, for these enthusiasts, time and money are the primary factors that hinder their pursuit of snowboarding.

Flexibility in learning time is essential for beginners, as it allows them to organize their learning according to their schedules. Additionally, flexibility in the learning location is also necessary, allowing learners to learn at home or other locations without traveling to snow areas and thus not be constrained by the external environment. The high cost of learning deters many beginners; therefore, many learners expect more economical learning options. To reduce anxiety and worry among beginners, it is also essential to create a friendly learning environment that provides an immersive experience so that they can transition more smoothly to natural snow scenarios. In terms of content, it is essential to provide easy-to-follow instructions and teaching methods that help snowboarders quickly adapt to their basic skills. At the same time, new technologies and formats are being integrated to enhance the learning experience and enhance the learning process. Simulations of realistic environments are presented in an artistic style to enhance the authenticity of the experience. The learning content covered knowledge of snowboarding equipment, including understanding the types of equipment, their functions, and their correct use. In addition, awareness of basic skills is the focus of instruction, and emphasis is given to essential skills that beginners must master. Developing safety awareness is equally important, including awareness of potential risks and taking appropriate safety precautions.

Figure 119
Education Experience Needs Model for Snowboarding Beginners



Source: Created by the author

An understanding of the facilities at a snowboard venue is also required, including what they are used for and how to use them effectively. Regarding growth paths, simplified technical instruction focuses on teaching primary and easy-to-master snowboarding skills to beginners or experienced snowboarders. Providing motivational support and positive feedback is encouraging for snowboard learners.

Social interaction plays a vital role in the snowboard edu-experience. Not only does it help to make friends, but it also provides opportunities for mutual practice. Learners can improve their skills through mutual encouragement and cooperation in a supportive environment. Social interaction can extend beyond the slopes, for example, by joining social or recreational activities after practice. Based on the above content, the researchers summarized the results into a model (Figure 119).

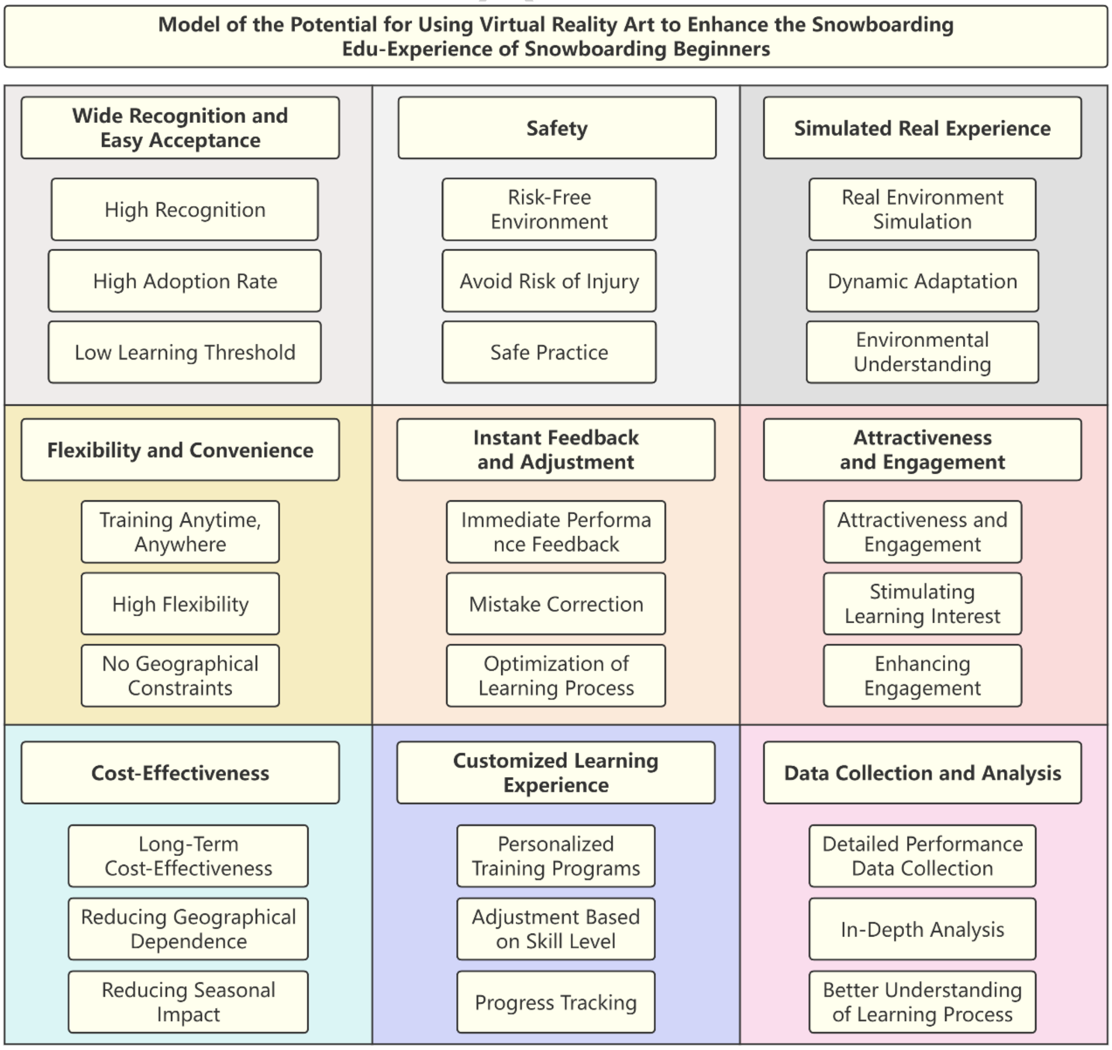
6.1.2 EFFECTIVENESS OF VIRTUAL REALITY ON LEARNING TOOLS FOR SNOWBOARDING BEGINNERS

Researchers have evaluated a range of technological means based on user needs, and the results of this study demonstrate that VR technology as an edu-experience carrier is currently the means that best meets user needs. VR has the following advantages as a vehicle for educational experience (Figure 120).

First, VR technology is widely recognized and has a high adoption rate among target users. This model reduces users' difficulty level and learning threshold to accept new technologies. As a result, users can use the proposed technology more easily without incurring additional learning costs. VR provides a risk-free environment that allows beginners to practice their snowboarding skills without the risk of falling or getting injured. VR technology can simulate the real snowboarding experience, creating an immersive user experience. This pathway helps snowboarding beginners understand and adapt to the environment and dynamics of snowboarding. Users can manipulate the VR remotely without needing to travel to an actual snow area and can train at any time and place. VR technology offers excellent learning flexibility. VR systems can provide instant performance feedback and coaching to help learners correct mistakes and optimize learning quickly. As an emerging technology, VR is highly sought after to stimulate learner interest and engagement, especially among young and technology-savvy groups. In the long term, VR training may be more cost-effective than traditional snowboard training, especially in terms of reducing dependence on location and snow season. VR allows for a customized learning experience, where training programs can be adapted to each learner's skill level and progression rate. VR technology allows the collection of detailed performance data, providing in-depth analyses for instructors and learners to better understand the learning process.

Figure 120

Technology Enhances the Edu-Experience of Snowboarding Beginners



Source: Created by the author

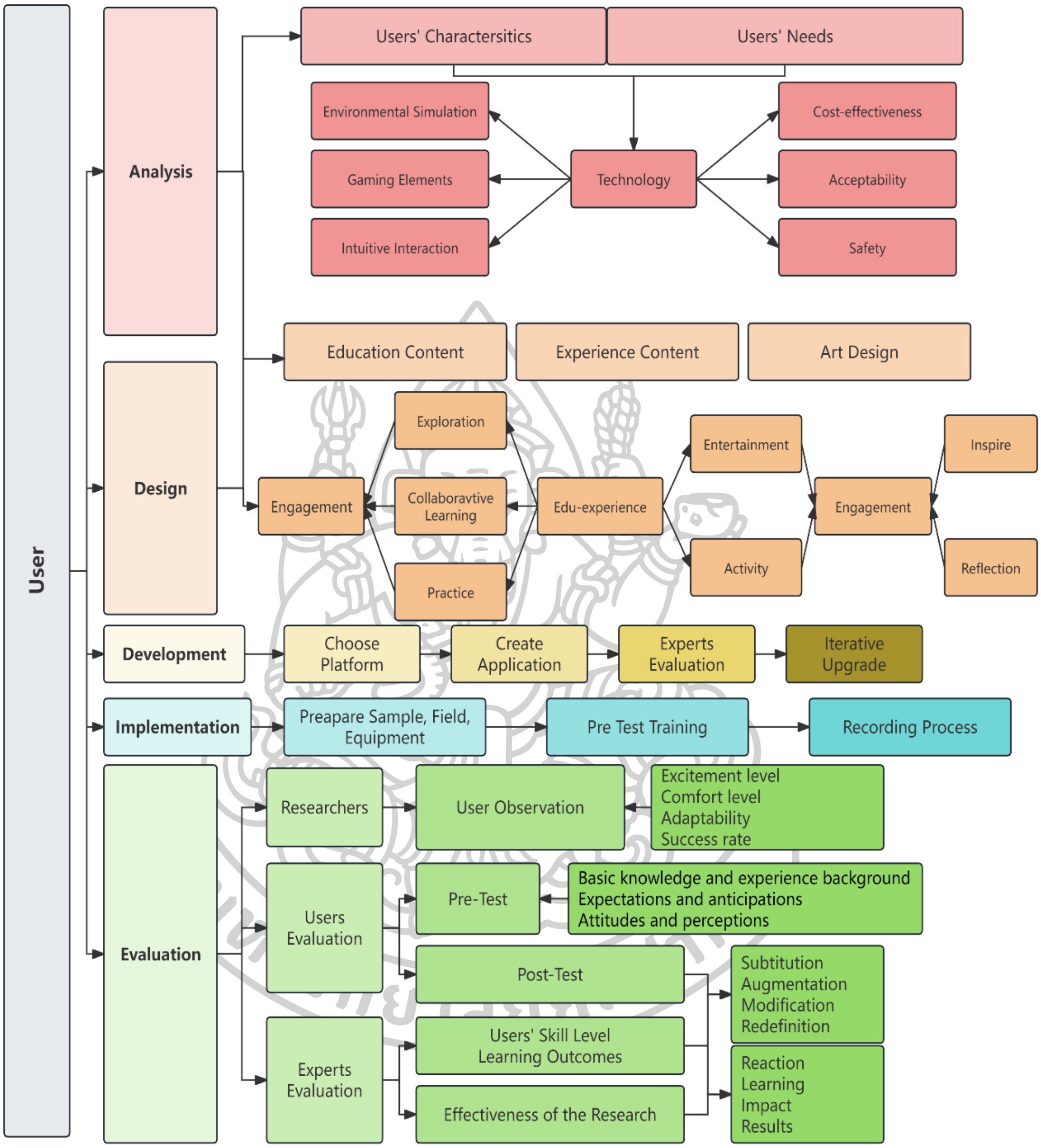
Therefore, choosing VR as a teaching profession can provide a safe, efficient, flexible, and engaging learning environment that is particularly suitable for beginners and those who wish to learn snowboarding in a new way.

6.1.3 DESIGN, DEVELOPMENT, AND EVALUATION OF VIRTUAL REALITY EDU-EXPERIENCE FOR BEGINNERS

The researchers designed, developed, and evaluated a VR educational experience for beginners. They used user-centered design (UCD) as the guiding principle for the entire process, from design to development and feedback and adjustments based on user needs. Following the steps of the ADDIE Learning Model—Analysis, Design, Development, Implementation, and Evaluation—they constructed educational content using Constructivist Learning Theory. The researchers designed a visually appealing and user-friendly VR interface using engaging graphics and colors to attract learners. High-quality images, clear sound effects, and realistic simulated environments stimulated learners' curiosity and interest. The VR application's interactive design was intuitive and smooth, making it easy for learners to understand how to operate in the virtual environment. Learning activities were created to connect with learners' interests and experiences, enhancing the emotional depth of the learning content and making the learning experience more meaningful and memorable. When designing educational activities, the researchers focused on the cognitive needs of beginners, created learning scenarios based on their growth paths, elicited positive emotional responses, and incorporated gamification elements to add fun to the learning process. VR's interactive and collaborative features were used to enhance learner engagement.

Figure 121

Virtual Reality Model for Edu-Experience for Snowboarding Beginners



Source: Created by the author

In the evaluation phase, the researchers assessed the research outcomes in two major areas: education and experience. The SAMR Model was used to determine whether the technology served merely as a substitute for traditional methods without adding new functionalities or advantages, to identify whether the technology provided additional benefits in improving teaching efficiency or learning experience, to evaluate whether the technology fundamentally changed learning tasks, and to examine whether the technology created entirely new learning methods and experiences. The Kirkpatrick Model provided a comprehensive evaluation framework, covering everything from learners' immediate reactions to the application of the learning outcomes. Because this study involved the application of VR technology in education, the Kirkpatrick Model was used to evaluate the direct and indirect impacts of this technology on teaching effectiveness. The study also assessed learners' reactions to the VR snowboarding tutorials and whether they applied the skills learned in the virtual environment to actual practice, examining the long-term impact on their snowboarding skills (Figure 121).

The results demonstrate that the educational experience achieved good scores across all evaluation criteria, and the user experience was satisfactory. As an educational tool for snowboarding beginners, VR has demonstrated significant potential and effectiveness. Through VR technology, beginners can learn in a safe, flexible, and efficient environment. This study has effectively reduced learning costs for snowboarding beginners, helped them quickly transition to real-world snowboarding skills, and promoted the inheritance and development of the winter sports culture. These results strongly support the application of VR in snowboarding education, indicating its vast potential and promising prospects in improving learning outcomes, enhancing learning experiences, and innovating teaching methods. The specific benefits of the study are shown below (Table 22):

Table 22

Specific Benefits of the Study

Feature	***Description***
Reduce Learning Costs	VR technology significantly reduces the learning costs associated with snowboarding by eliminating the need to travel to ski resorts, purchase expensive gear, and pay for professional instruction. Reduced logistical expenses and the ability to practice without incurring additional costs make snowboarding more accessible to a wider audience.
Safety	VR technology provides a risk-free learning environment, allowing beginners to practice snowboarding without the real risk of falling or getting injured. This safe learning environment enabled beginners to practice more confidently, thus reducing the fear and anxiety they might encounter in a natural environment.
Flexibility	VR technology allows students to train at any time and place without going to actual mountains or ski resorts. This flexibility significantly reduced learning time and economic costs, making snowboarding more accessible to a broader audience.
Realistic	VR technology can simulate natural snowboarding environments and dynamics to help beginners understand and adapt to the actual requirements of snowboarding.
Simulation	Through highly realistic visual simulations, learners could experience the natural feeling of snowboarding, which helped them adapt to the environment more quickly when they snowboarded in the real world.
Engagement	VR is an emerging technology, especially for young and tech-savvy groups. The study found that VR technology could stimulate learners' interest and engagement, making them more actively participate in learning. Using engaging graphics, colors, and sound designs, the VR environment could maintain learners' attention and enhance their motivation. High levels of engagement played a crucial role in improving learning outcomes.
Effectiveness	In the long term, VR training was more cost-effective than traditional snowboarding training. VR reduced the dependence on geography. Location and snow seasons allow learners to train without being limited by time and place. Additionally, VR technology allows the customization of learning content based on learners' needs and progress. Personalized learning plans could more effectively meet each learner's needs and improve learning outcomes.

Source: Compiled by the author

6.2 DISCUSSION

This study explored the potential of VR art as an educational tool for snowboarding beginners and demonstrated its significant advantages and effectiveness from multiple perspectives. VR technology provides a safe, flexible, and efficient learning environment and enhances learners' interest and engagement, thus accelerating skill acquisition and improving learning outcomes. Despite some limitations and challenges, the application of VR technology in snowboarding education has promising prospects, offering essential references for future innovations in educational models. Through continuous improvement and optimization, virtual reality is expected to leverage its unique advantages in more fields, driving a comprehensive revolution in educational methods.

6.2.1 COMPARE THE FINDINGS

6.2.1.1 COMPARE WITH OTHER RESEARCH

The researchers conducted a comparative analysis with related studies, focusing on studies involving snowboard simulation devices, virtual or augmented reality snowboarding, and VR education and training.

1) Similarities

Due to the unique constraints of snowboarding as a winter extreme sport, namely seasonal and physical ability limitations, all studies on snowboarding devices emphasized safety. These studies also explained that VR technology provides a safe learning environment, thus reducing the risks associated with physical activity. For example, Chang-hoon et al. (2014) demonstrated that VR technology could reduce injury risks in snowboarding and other sports (Park, 2014). Additionally, studies such as "The Development of a Game Simulator for Snowboards" indicated that the application of VR technology in snowboarding education dramatically enhances safety. Snowboarding game simulators, which measure users' movements and convey physical changes, allow users to practice snowboarding techniques in a risk-free environment, thereby reducing the risk of injury during physical activities. Another study on the development of a snowboard game simulator indicated that the application of VR technology in snowboarding education dramatically enhances safety (Kim & Yoon, 2019). Snowboarding game simulators measure users' movements and convey physical changes, allowing users to practice snowboarding techniques in a risk-free environment, thereby reducing the risk of injury during physical activities.

The second similarity is that using VR technology significantly improved learning efficiency. A study on "Learning Support and Evaluation of Weight-Shifting Skills for Novice Skiers Using Virtual Reality" found that learners could better understand and adjust their snowboarding posture and balance through real-time and visual feedback, improving learning outcomes (Ono, Kanai, Atsumi, Koike, & Nishimoto, 2022). Another study also emphasized that visualizing expert movements could help learners better understand and mimic snowboarding techniques, thereby improving learning outcomes (Nozawa, Wu, Perteneder, & Koike, 2019).

The third similarity is technological immersion. In two other studies related to VR snowboarding, it was confirmed, similar to this study, that users could mimic expert movements in a virtual snowboarding scenario through VR head-mounted displays, obtaining a sensation similar to an actual snowboard (Fan, Seigneur, Guislain, Nanayakkara, & Inami, 2016; Nozawa, Wu, & Koike, 2019).

The fourth similarity is technological adaptability. While many studies have emphasized the high adaptability of virtual reality technology, this study found that some learners encountered adaptability challenges when first using VR equipment. This could be related to the complexity of the equipment and users' technical backgrounds. To improve technological adaptability, the study emphasized the importance of simplicity and user-friendliness in the design of VR interfaces. Continuously improving the VR system based on user feedback and ensuring the equipment and interface usability will help lower the learning threshold for users, making the technology more accessible and usable for beginners. A study on reducing the surgical learning curve for surgeons also mentioned that a user-friendly interface is a critical factor in enhancing user adaptability to VR equipment (Munawar et al., 2024).

2) Differences

Other related studies have focused on how adding auxiliary equipment enhances learners' and users' learning achievements and skill improvement. These studies explored the role of VR technology, augmented by external devices, in accelerating skill acquisition, improving learning efficiency, and optimizing learning outcomes. Some studies have demonstrated the importance of external devices in enhancing learners' skills and achievements (Park, 2014; Wood, Loizides, Hartley, & Worrallo, 2017). In contrast, this study focused more on the educational experience needs of snowboard beginners than on skill acquisition. Skill learning was a part of the study; however, the primary focus was on the comprehensive assessment of beginners' educational experiences. This study supported highly personalized learning experiences, with user satisfaction as its cornerstone. All adjustments and modifications were made based on user experience, from design and development to testing and feedback.

The researchers conducted detailed surveys and analyses to identify snowboarding beginners' educational experience needs. These included flexible learning time and location, affordable learning options, beginner-friendly environments, accessible teaching content, engaging learning methods, and realistic environment simulations. Special attention was also given to beginners' growth paths, ensuring that their learning experiences were not merely repetitive and mechanical but enriched by simplified techniques, encouragement, and social interaction.

Through this comprehensive evaluation, we can better understand how VR technology impacts learning processes and experiences for beginners. Compared to other studies that focused primarily on skill enhancement, this study aimed to improve skills and optimize and enrich the educational experience for beginners. This approach provides additional references and support for future innovations in educational models.

These comparisons show that this study differs significantly from related studies in terms of research methods and focus. Other studies have focused either on how the integration of external devices enhances learners' skill levels or on how VR teaching platforms improve learning efficiency. However, this study aimed to improve skills and placed greater emphasis on the educational experiences of beginners. Additionally, this study paid particular attention to the growth paths of beginners, which not only helped them improve their mastery of snowboarding skills but also increased their interest and motivation, thereby improving overall learning outcomes.

By comprehensively assessing the educational needs of beginners, the researchers developed a series of methods to optimize their educational experiences. This all-encompassing evaluation provides a better understanding of how VR technology impacts learning processes and experiences for beginners, providing more references and support for future innovations in educational models.

This study not only differed significantly from other studies in terms of methods but also took a more comprehensive and inclusive approach in its research focus. By optimizing the educational experience, we aimed to improve overall learning outcomes and satisfaction for beginners. These findings provide important references for future innovations in educational models and demonstrate the great potential of VR technology in snowboarding education.

6.2.1.2 COMPARE WITH THE SAME THEORY IN OTHER RESEARCH

The ADDIE Learning Model is a valuable framework that has been widely used in various learning-related studies. This model is also commonly used in studies on sports learning (Spatioti, Kazanidis, & Pange, 2022). The ADDIE Model's flexibility allows it to be applied to all learning environments (Trust & Pektas, 2018). This study also used the ADDIE Learning Model as a fundamental guiding framework for the educational experiences of snowboarding beginners.

In previous studies, the ADDIE Model has been widely used for educational design and development to ensure the systematic and effective implementation of instructional activities. Below is a comparison of the similarities and differences between studies that used the ADDIE Model and this study:

1) Similarities

Systematic Design Approach: Most studies using the ADDIE Model followed a systematic design approach, progressing through the analysis, design, development, implementation, and evaluation stages of the model. Similarly, this study strictly adhered to each step of the ADDIE Model, ensuring high quality and applicability of the educational content through a systematic design approach.

User Needs Analysis:

In the analysis phase, an in-depth analysis of the characteristics and needs of target users is a critical step in the proposed ADDIE Model. Previous studies typically collected user data through surveys and interviews to understand user needs. This study conducted a detailed analysis and needs assessment of the target users to understand their age range, educational level, economic status, and learning preferences, providing a basis for subsequent design.

Design of Educational Content and Evaluation Tools: Previous studies usually planned educational content and evaluation tools in detail during the design phase to ensure that instructional activities effectively achieved learning objectives. This study developed detailed educational content and evaluation tools during the design phase, including highly interactive learning activities and multi-dimensional evaluation methods, to ensure learning effectiveness.

2) Differences

User-Educational Experience-Oriented Learning Research: Many previous studies using the ADDIE Model have focused on delivering instructional content and evaluating effectiveness. They primarily emphasized acquiring and assessing knowledge and skills and stressed the standardization and systematization of teaching. Users' emotional experiences and interactive feelings were often only partially considered. The researchers also used gamification methods to improve elementary students' sports skills, cooperation abilities, and discipline through a sports game learning model (Fizi, Winarni, & Hartanto, 2023). However, the evaluation results measured learning outcomes without assessing the students' experiential feelings. In a study on basketball technique instruction, the research goals focused more on the quantitative evaluation of teaching effectiveness, with less attention given to the learners' overall experience (Gong, 2023). In a study on using the ADDIE Model to develop online continuing education for nurse care, although they focused on learners' self-assessments, the researchers comprehensively evaluated emotional and interactive experiences throughout the learning process comprehensively (Hsu, Lee-Hsieh, Turton, & Cheng, 2014).

This study placed users' educational experience at the center, emphasizing providing a highly immersive and interactive learning environment through VR technology. It focused on learners' emotions and experiences during the learning process, enabling them to learn in an enjoyable and engaging state. By incorporating Emotional Design Theory and gamification elements, this study aimed to improve learning outcomes and enhance learners' emotional experiences and engagement. For example, vivid visual effects, gamified design, and immersive learning environments significantly enhance users' learning experience. This study also paid particular attention to personalized learning paths and social interactions, providing customized learning experiences and enhancing the collaborative and supportive nature of learning through social interactions. Such a user-centered design approach is relatively rare in traditional applications of the ADDIE Model.

In previous applications of the ADDIE Model, the use of Emotional Design Theory has been relatively limited, with most studies failing to fully leverage emotional design to enhance the learning experience. This study adopted Emotional Design Theory in the design phase, using vivid visual effects and interactive designs to elicit positive emotional responses from learners, thereby increasing the attractiveness and engagement of the learning experience.

Comparing previous studies using the ADDIE Model with the present study revealed a high degree of similarity in terms of systematic design methods and user needs analysis. However, significant differences exist in technological implementation, immersive learning environments, gamification elements, and emotional design applications. These differences highlight the innovative aspects of this study and provide new insights and directions for future educational design.

6.3 RECOMMENDATIONS

Based on the results and discussion of this study, some suggestions for applying VR technology to the education of snowboarding beginners. These recommendations aim to further optimize VR educational tools, enhance learning outcomes, and provide guidance for future research and practice.

1) Improving Accessibility of VR Equipment and External Devices

The high cost of VR equipment is a significant barrier for beginners. Although external devices, such as motion trackers and simulators, can provide more precise feedback, their higher cost makes them less accessible than VR headsets. Suggestions include:

Establish VR Community Centers: Creating VR community centers can provide snowboarding beginners with safe, efficient, and enjoyable learning environments. This will help them better master snowboarding techniques while increasing their engagement and satisfaction. This will promote snowboarding and serve as an important demonstration and reference for the application of VR technology in education.

Reduce Equipment Costs: Encourage technological advancements and market competition to lower VR equipment production and purchasing costs.

Offer Rental Services: Ski resorts, educational institutions, snow shops, and VR experience stores can offer VR equipment rental services, allowing more beginners to experience the technology at a lower cost.

Promote VR Education Programs: Government subsidies and corporate sponsorships can promote the application of VR technology in education, enabling more people to benefit from it.

2) Enhancing the Interactivity and Immersion of VR Content

To further improve learners' experiences and learning outcomes, the design of the VR content should focus on the following:

Enrich Interactive Elements: This step adds more interactive scenes and tasks, allowing learners to engage in diverse exercises and operations in the VR environment.

Increase Immersion: High-quality images, sound, and haptic feedback are utilized to enhance the realism of the VR environment, allowing learners to immerse themselves more deeply in their learning.

Scenario Simulation and Storytelling: Scenario simulations and storytelling add emotional depth and memorable points to the learning content, helping learners better grasp skills and knowledge.

3) Personalized Learning Paths and Feedback Mechanisms

Providing personalized learning paths and real-time feedback based on learners' needs and progress can improve learning efficiency and outcomes. Suggestions include:

Customized Learning Plans: These plans automatically adjust learning content and difficulty based on learners’ skill levels and progress, offering a personalized learning experience.

Real-Time Feedback Systems: Develop more detailed real-time feedback systems to help learners quickly identify and correct errors, thus optimizing learning.

Data-Driven Teaching Improvements: Using detailed learning data from VR technology to analyze learners’ behaviors and performance to continually improve teaching content and methods.

4) Strengthening Safety Education and Awareness

VR technology can simulate various scenarios in a natural snowboarding environment, allowing beginners to enhance their safety awareness and protective skills. Suggestions include:

Safety Education Modules: This module includes modules on snowboarding safety and risk management in the VR educational content, emphasizing the use of protective gear and the importance of safety measures.

Simulating Emergency Situations: The VR was used to simulate potential emergencies and dangerous scenarios during snowboarding, train the learners’ emergency response abilities, and reduce injury risks in fundamental snowboarding.

5) Promote Social Interaction and Group Learning:

Social interaction is crucial to learning, enhancing learners’ engagement and motivation. Suggestions include:

VR Social Platforms: Develop VR social platforms where learners can interact with other snowboarding enthusiasts and share their experiences and techniques.

Collaborative Learning Activities: Design collaborative learning activities in VR to promote cooperation and communication among learners and enhance team spirit and social skills.

Extending Social Activities: After completing VR practice, encourage learners to participate in social activities and recreational events at actual ski resorts, strengthening the connection between virtual and natural environments.

6.4 RESEARCH LIMITATIONS

Sample Size Limitation: This study's research sample was primarily collected from Asian countries, which may not fully represent the educational experience needs of all snowboarding beginners. This could affect the generalizability and applicability of the research results.

Time and resource limitations: Developing and testing a VR educational experience for snowboarding beginners requires significant time and resources, potentially limiting the depth and breadth of the study.

Technical Limitations: The inherent limitations of VR technology, such as resolution, refresh rate, device compatibility, and unavoidable physiological issues like motion sickness, could impact user experience and learning outcomes. These technical limitations might result in the research findings needing to reflect VR education's potential fully.

Differences in Participants' Technical Backgrounds and Athletic Abilities: Variations in participants' technical backgrounds could affect their adaptability and experience with VR equipment. Some participants might need to become more familiar with VR technology, leading to a steep learning curve and impacting their educational experiences and research outcomes. In addition, participants with limited athletic abilities may need help with snowboarding skills.

External Factors: Participants' daily life and work pressures, health conditions, and other factors could influence their motivation and engagement in learning. These factors affect the reliability of the research results to some extent.

Limitations in Data Collection and Analysis: The data collection and analysis process may contain errors and biases, which may affect the accuracy and reliability of the research results. For example, participants’ subjective factors could influence the design and implementation of questionnaire surveys, thus impacting the authenticity and representativeness of the data.

By identifying and understanding these research limitations, future studies can address them further to enhance the quality and reliability of the research.

6.5 FUTURE RESEARCH DIRECTIONS

Based on the findings and limitations of this study, future research can explore the following directions:

Cost-Effective and Recommended External Devices: Adding external devices significantly enhances user experience. It is crucial to simplify external devices, reduce production costs, and increase their usage rate.

Long-Term Effect Evaluation: Conduct long-term follow-up studies to assess the impact of VR educational tools on learners’ long-term skill development and their effectiveness in real-world applications.

User Adaptability Research: This study investigates the differences in adaptability to VR technology among users of different ages, genders, and backgrounds to develop more targeted teaching strategies.

Technological improvements: The performance and user experience of VR equipment’s performance and user experience and develop more advanced interactive and immersive learning technologies.

Cross-Disciplinary Applications: The application of VR technology in other extreme sports and physical education is explored to validate its effectiveness across different sports disciplines.

6.6 CHAPTER SUMMARY

VR demonstrated significant advantages in the education of snowboarding beginners, providing a safe, efficient, and flexible learning environment that allowed beginners to master their snowboarding techniques quickly. The research results indicate that incorporating VR educational experiences into traditional teaching methods can enhance learners' progress and significantly boost their interest and engagement through rich interactive and immersive experiences. The enormous potential of VR in enhancing learning experiences, improving learning outcomes, and reducing learning costs strongly supports its application in snowboarding education. The findings are consistent with existing literature on providing safe learning environments and improving learning efficiency through VR. Additionally, the challenges related to the adaptability of VR equipment have expanded the existing research, emphasizing the unique advantages of VR technology in providing customized learning experiences. The results supported the application of VR in snowboarding education and laid the foundation for future educational model innovations. As an emerging educational tool, VR has broad application prospects and development potential, which can drive comprehensive innovation in educational methods.

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APPENDIX

No.8610/ 2516

Faculty of Decorative Arts, Silpakorn University
Na Phra Larn Rd., Phra Borom Maha Ratchawang
Phra Nakhon, Bangkok 10200 Thailand

13th June, 2023

Subject: Invitation to be an inspector of research tool quality

Dear Professor Dr. Miyoung Seo

Ms. Siqi Zhang is a graduate student ID 640430004 in Design Program at Graduate School, Silpakorn University. Currently, he is conducting his thesis study entitled: Virtual Reality Arts in Snowboarding Edu-Experience for Beginners. In this regard, Graduate School, Silpakorn University would like to invite you to inspect the quality of research tools for the student.

Your kind assistance and academic contribution is much appreciated.

T. Jiarakun

(Dr. Thanatorn Jiarakun)
Dean of Faculty of Decorative Arts,
Silpakorn University

Contact to : info.decsu@gmail.com
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ที่ อว 8610 / 2512

คณะมัณฑนศิลป์ มหาวิทยาลัยศิลปากร
31 ถนนหน้าพระลาน แขวงพระบรมมหาราชวัง
เขตพระนคร กรุงเทพฯ 10200

13 มิถุนายน 2566

เรื่อง ขอเชิญเป็นผู้ตรวจคุณภาพเครื่องมือวิจัย

เรียน รองศาสตราจารย์ ดร.เกรียงศักดิ์ เขียวมั่ง

ด้วย Ms. Siqi Zhang รหัสประจำตัว 640430004 นักศึกษาหลักสูตรปรัชญาดุษฎีบัณฑิต สาขาวิชาการออกแบบ คณะมัณฑนศิลป์ มหาวิทยาลัยศิลปากร หัวข้อดุษฎีนิพนธ์ เรื่อง Virtual Reality Arts Snowboarding Edu-Experience for Beginners. โดยมี ผู้ช่วยศาสตราจารย์ ดร.อติเทพ แจ้ดนาลาว เป็นอาจารย์ที่ปรึกษาวิทยานิพนธ์ นั้น

ในการนี้ คณะมัณฑนศิลป์ จึงขอเรียนเชิญท่านเป็นผู้เชี่ยวชาญตรวจเครื่องมือวิจัยให้กับนักศึกษา เพื่อนักศึกษาจะได้นำข้อเสนอแนะที่ได้ไปปรับปรุงคุณภาพเครื่องมือการวิจัยให้มีความเหมาะสมต่อไป

จึงเรียนมาเพื่อโปรดพิจารณา คณะฯ หวังเป็นอย่างยิ่งว่าจะได้รับความอนุเคราะห์จากท่าน และขอขอบพระคุณเป็นอย่างสูงมา ณ โอกาสนี้

ขอแสดงความนับถือ

(อาจารย์ ดร.ธนาทร เจียรกุล)
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13 มิถุนายน 2566

เรื่อง ขอเชิญเป็นผู้ตรวจคุณภาพเครื่องมือวิจัย

เรียน ศาสตราจารย์เกียรติคุณวัฒนะ จูฑะวิภาต

ด้วย Ms. Siqi Zhang รหัสประจำตัว 640430004 นักศึกษาหลักสูตรปรัชญาดุษฎีบัณฑิต สาขาวิชาการออกแบบ คณะมัณฑนศิลป์ มหาวิทยาลัยศิลปากร หัวข้อดุษฎีนิพนธ์ เรื่อง Virtual Reality Arts Snowboarding Edu-Experience for Beginners โดยมี ผู้ช่วยศาสตราจารย์ ดร.อดิเทพ แจ้ดนาลาว เป็นอาจารย์ที่ปรึกษาวิทยานิพนธ์ นั้น

ในการนี้ คณะมัณฑนศิลป์ จึงขอเรียนเชิญท่านเป็นผู้เชี่ยวชาญตรวจเครื่องมือวิจัยให้กับนักศึกษา เพื่อนักศึกษาจะได้นำข้อเสนอแนะที่ได้ไปปรับปรุงคุณภาพเครื่องมือการวิจัยให้มีความเหมาะสมต่อไป

จึงเรียนมาเพื่อโปรดพิจารณา คณะฯ หวังเป็นอย่างยิ่งว่าจะได้รับความอนุเคราะห์จากท่าน และขอขอบพระคุณเป็นอย่างสูงมา ณ โอกาสนี้

ขอแสดงความนับถือ

(อาจารย์ ดร.ธนาทร เจียรกุล)
คณบดีคณะมัณฑนศิลป์

สำนักงานคณบดี
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Co-organized by

CERTIFICATE OF ATTENDANCE

This Certificate is Presented to

Siqi Zhang and Chaetnalao Atithep

For Presenting the Research Article Entitle

Exploring the Feasibility of Virtual Reality for the Educational Experience of Snowboarding Beginners

The 7th International Conference on Learning Innovation *in* Science and Technology (ICLIST 2024)
Organized by the Faculty *of Industrial* Education and Technology
King Mongkut's University of Technology Thonburi
on March 21–23, 2024 at Amari Pattaya Hotel

T. Tanitteerapan

(Associate *Professor Dr.*Tanes Tanitteerapan)
Honorary Chairman
Dean of Faculty of Industrial Education and Technology

IC06 The 7th International Conference on Learning Innovation in Science and Technology (ICLIST 2024), March 21-23, 2024, Pattaya, Thailand, and Online

Exploring the Feasibility of Virtual Reality for the Educational Experience of Snowboarding Beginners

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Faculty of Decorative Arts, Silpakorn University, Wang Tha Phra Campus No.31, Na Pralan Road, Phra Boeom Maha Ratchawang, Phra Nakhon, Bangkok 10200, Thailand
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Abstract

The potential of virtual reality (VR) art as a teaching tool in skill-based education, particularly in snowboarding, is increasingly recognized. This complex winter sport requires integrated body coordination, strength, and balance, making training challenging for beginners. Traditional teaching methods involve on-site guidance and extensive practice, posing potential safety risks and high time and financial demands. The advent of VR art offers a safer, interactive learning environment. As an immersive technological art form, VR could enhance skill training efficiency and safety. This article will explore the feasibility of VR art in snowboarding education, providing an overview of the basics, potential applications, challenges, and limitations. The objective is to offer valuable insights for future VR application in snowboarding education.

Keywords: Virtual Reality, Snowboarding Education Experience, Interactive Teaching

1. Introduction

In the domain of education, particularly in the realm of skill training, virtual reality (VR) art has been increasingly recognized as a tool of immense potential [1]. This is especially pertinent for snowboarding, a complex skill that demands a holistic coordination of physical agility, strength, and balance [2]. Determining how to effectively integrate virtual reality art to enhance the educational experience for beginners in snowboarding has emerged as a novel research direction. The objective of this paper is to explore the feasibility of virtual reality art in enriching the educational experience for snowboarding beginners.

Snowboarding, a globally popular winter sport, presents a relatively complex training regimen, posing numerous challenges for beginners [3]. Traditional teaching methods primarily rely on on-site instruction and extensive practice, which not only potentially incur certain safety risks but also place considerable demands on beginners in terms of time and financial investment. Moreover, the learning progress is often constrained by individual physical conditions and learning capabilities. In this context, the advent of virtual reality art offers a fresh perspective in addressing these issues.

Virtual reality (VR) art, an emerging form of technological art, creates an immersive and interactive learning environment, allowing learners to practice in a relatively safe setting. This mode of education has the potential to elevate the efficiency and safety of skill training to a new level [4].

Building on this, the article will commence with an overview of the basic circumstances surrounding virtual reality art and snowboarding education, analyzing the potential applications of virtual reality art in snowboarding education, as well as the challenges and limitations it faces. We hope that this review will provide valuable references and insights for future applications of virtual reality art in snowboarding education, contributing to the ongoing discourse and innovation in this field.

1.1 The Foundation of Virtual Reality Art

Virtual Reality (VR) technology encompasses the utilization of computer-generated simulated environments, which are three-dimensional and enable users to feel immersed within the environment, transcending the role of mere observers [5] (Figure 1). The inception of this technology can be traced back to the 1960s, when the concept of virtual reality was first introduced [6]. However, it was not until the recent advancements in technology, such as more potent computer hardware and refined sensor technology, that VR truly realized its potential.

No. 0603.02/0582

Office of the Graduate School,
Naresuan University, Taphao District
Muang, Phitsanulok 65000

February 23, 2024

Subject: Manuscript accepted for publication

Dear Ms. Zhang Siqi

The Editorial Board of Journal of Community Development Research (Humanities and Social Sciences) is pleased to inform you that your manuscript entitled **"A New Perspective on Snowboarding: An In-depth Exploration of Beginner Education Experiences"** is accepted for publication. The manuscript will be published in Volume 17 No. 1 (January - March 2024).

Thank you for your contribution to Journal of Community Development Research (Humanities and Social Sciences).

Sincerely yours,

(Associate Professor Dr. Watana Padgate)
Editor-in-Chief

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A New Perspective on Snowboarding: An In-depth Exploration of Beginner Education Experiences

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Received: 21 January 2024; Revised: 21 February 2024; Accepted: 23 February 2024; Available Online: 19 March 2024

Abstract

This research explores the educational experiences of snowboarding beginners, focusing on identifying the key challenges they encounter and evaluating the effectiveness of existing instructional resources. Employing a mixed-method approach, this study investigates the learning processes of snowboarding beginners through field observations at two ski resorts in China and Thailand, in-depth interviews with three instructors, two ski resort managers, and 10 snowboarders, and a survey of 450 participants from which 429 responses were deemed valid. The aim is to shed light on the nuanced learning experiences of novice snowboarders. The comprehensive methodology provides a rich dataset for understanding the complexities of beginner experiences in snowboarding education. The findings reveal significant gaps in safety awareness and underscore the necessity for more cost-effective learning strategies. By integrating emerging technologies such as virtual reality, this study proposes innovative solutions to enhance the learning experience, making it more engaging and financially accessible. The research contributes to the academic discourse on physical education and technology's role in sports training, offering valuable insights for educators and policymakers to improve snowboarding instruction, focusing on safety, affordability, and learner engagement. This abstract encapsulates the essence of the paper, providing a clear overview of the study's objectives, methods, key findings, and implications for future research and practical application in the field of snowboarding education.

Keywords: Snowboarding Beginners, Education Experiences, Learning Strategies, Flexible Learning, Affordability

Introduction

Snowboarding, rapidly emerging as a popular sport in winter activities (Stepan et al., 2023), has garnered significant attention and participation from beginners worldwide in recent years (Barjolin-Smith, 2020). This sport is unique in winter activities due to its distinctive blend of thrill and entertainment (Thorpe, 2012). It provides an excellent platform for those seeking excitement and enjoyment in the snow (Brunner et al., 2015). It challenges the athletes' limits and brings an unparalleled sense of exhilaration and satisfaction (Ruedl et al., 2013). With the growing popularity of winter sports and the rise in snow tourism, snowboarding has evolved into a global trend, increasingly attracting enthusiasts and beginners (Happ et al., 2023). Although the sport is fun and exciting, learning to snowboard and mastering its essence is a challenge (Reichenfeld & Bruechert, 1995).

Additionally, the high costs associated with learning, including fees for access to facilities (Okada et al., 2023), equipment rental, and coaching, limit the influx of interested individuals into the sport (Kotro & Pantzar, 2002). Therefore, providing effective learning pathways and appropriate educational support for beginners is paramount (Pothier, 2003). Understanding and meeting the educational needs of these beginners not only enhances their learning efficiency but significantly boosts their overall learning experience.

As global interest in winter sports continues to grow, snowboarding, a key activity within this realm, showcases significant industry trends and characteristics. Recently, snowboarding's popularity has surged not only in traditional winter sport powerhouses but also in warmer regions through indoor facilities, establishing it as a global sport bridging various cultures and geographies. With the approach of the 2022 Beijing Winter Olympics and

August 16, 2024

Dear Siqi Zhang and Atithep Chaetnalao

As you have submitted a research article for consideration for publication in the academic and research circles at the national level. The editorial team held a screening meeting. and select qualified experts to read and evaluate your article.

The editorial team is pleased to inform you that I know that your article Subject: **"Theoretical Analysis of Teaching Models for Snowboarding Beginners"** by the editorial team Your article has been sent to 3 experts, including experts from many institutions. and be an expert in the field of study related to your article which has evaluation results at the level "Passed" and published in the Journal of the Pacific Institute of Management Sciences. (Humanities and Social Sciences) Year 11 Issue 1 January - April 2025 Number Online ISSN: 2697- 4487 Print ISSN: 2586-8462 The journal is in the database. Thai Journal Citation Index Center, Group 2

Thank you very much for your participation. We looking forward to seeing your next journal.

Sincerely,

(Dr.Pensri Bangbon)
Editor

Theoretical Analysis of Teaching Models for Snowboarding Beginners

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Abstract

This paper reviews a variety of educational theories and models for teaching snowboarding beginners, including the ADDIE model, Kolb's experiential learning theory, Bloom's Cognitive Domain Educational Objectives Framework, and Gagne's Nine-Step Instructional Model, and evaluates their effectiveness and applicability. It was found that these models and theories can significantly enhance the quality of instruction and the overall experience of learners, especially in terms of skill acquisition and theory application. However, there is a considerable gap between theory and practice, which is mainly caused by the educational environment, resource constraints, insufficient educator-learner interactions, and the limitations of the theories themselves. The article suggests that educators should continue to explore and experiment with different instructional models and make necessary adjustments to suit specific teaching and learning environments and learner needs. It is also suggested that more empirical studies should be conducted to validate the long-term effectiveness of these instructional models and to explore ways to reduce the discrepancies between theory and practice in order to optimise teaching strategies and improve educational outcomes.

Keywords: Snowboarding; Pedagogical modelling; Educational theory; Empirical research; Skill acquisition

Introduction

Snowboarding, a winter sport that combines speed, skill and adventure, is not only an official Olympic sport, but also a recreational choice for millions of enthusiasts worldwide (Thorpe, 2012). Born in the late 1960s, the sport originally evolved from snowboarding, and by binding the feet to a board, athletes glide and execute tricks on snowy slopes (Oudit, 2005). Unique in that it combines elements of skiing and skateboarding, snowboarding offers a great deal of freedom and creativity, making each descent full of personalised expression (Althen, 2015). Over time, snowboarding quickly evolved from a fringe sport to an international sporting activity. Its inclusion in the Olympic Winter Games in 1998 not only increased the sport's

STORY BOARD

Click on the App 'VRChat'

Select platform entrance

Enter account and password

Search for 'snowboarding'

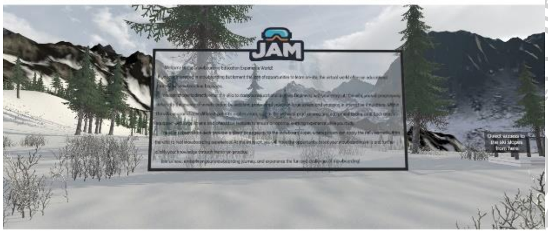
Click on the icon

Waiting for loading

Turn right to see the Learning Center.

Virtual world loading completed, perspective appears at birth point.

Come to the front door of the Learning Center.

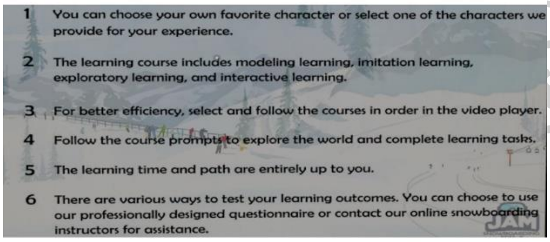


Read the abstract of the virtual reality world.

Open the door to the Learning Center.

After entering the Learning Center, read the introduction of learning methods.

After reading, you can also choose to turn left or other directions, and the tour route of this world is determined by the user.



Introduction content

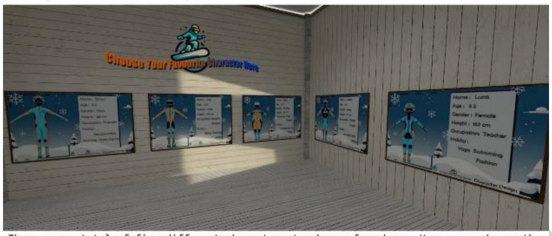
On the left corridor, you can see three directions to move forward.

After reading, you can start the educational experience journey by choosing to turn right and go to the character selection area.

You can choose to turn left and go downstairs, or go straight to the balcony for sightseeing.

The right side of the learning center is the virtual character selection area.

Preview Character



There are a total of five different characters to choose from here. Users can choose the appropriate role based on the details.

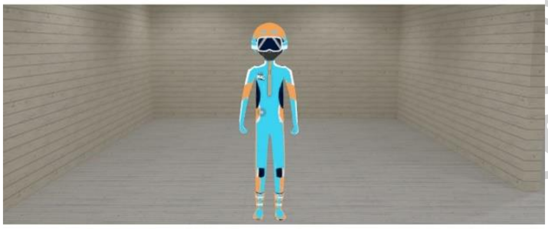
Preview Character

Preview Character

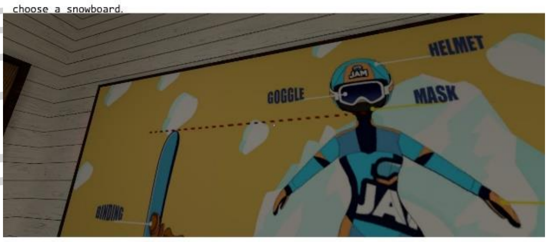
Preview Character

Preview Character

The image on the wall shows an explanatory diagram of snowboarding equipment and how to choose a snowboard.



Select a role. (Here is an example placed.)

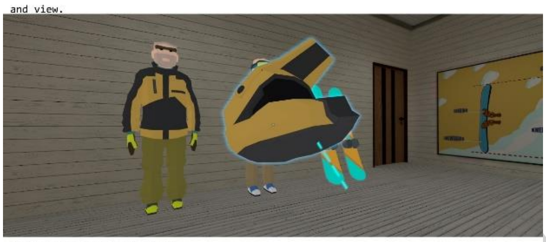


By adjusting the perspective, the details of each part can be fully observed.

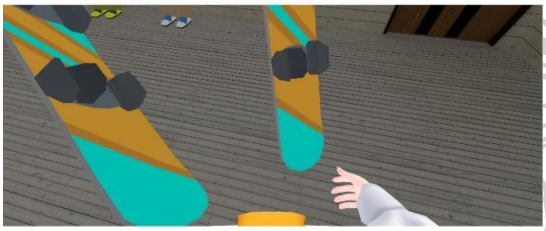
After selecting the character, turn back and enter the room.

After learning the equipment explanation diagram, you can experience them in the room.

There are some snowboarding equipment models placed in the room, which players can hold and view.



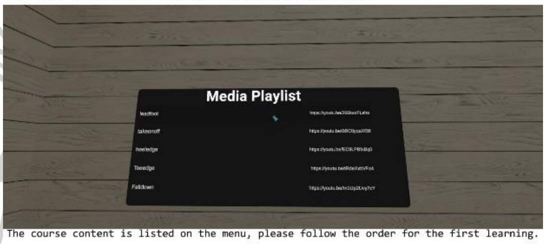
Pick up the helmet to check.



Pick up the snowboard and check.

Next, turn to the direction of the large screen in the room to start learning the skills course.

The player consists of a large screen and a menu combination.



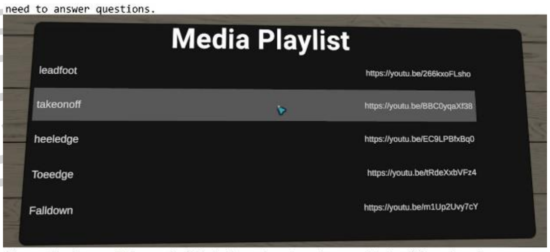
The course content is listed on the menu, please follow the order for the first learning. User can choose according to the user's own learning plan later.

Choose the lesson ‘Lead foot’ to learn how to choose the lead foot.

After loading, the lesson title will appear on the large screen.

This is the controller of the player, where users can adjust play, stop, progress, volume, and other functions.

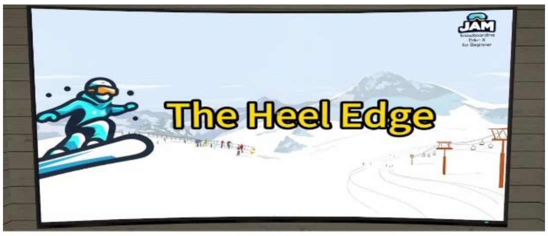
"Test Time" appears on the screen, indicating that the test time has entered. Players need to answer questions.



Choose the lesson 'take on & off' to learn how to put on and take off snowboards.

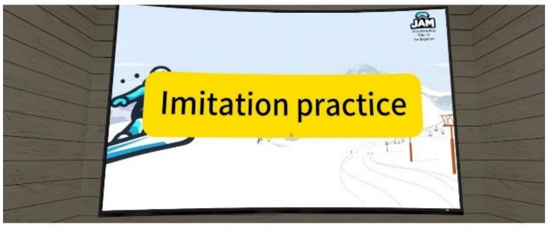
After successful loading, the lesson will start playing on the screen.

After the lesson ends, "Test Time" appears on the screen, indicating that the user is about to enter the assessment time.



The big screen starts playing the lesson.

Complete the task according to the prompts.



The appearance of "Imitation practice" on the screen means that the user needs to imitate and learn from the actions on the screen at this time.

Choose the lesson 'heel edge' to learn the heel edge (back edge).

Prepare to imitate learning.

Follow and imitate actions appear on the screen, users need to follow and learn.

Go down the stairs.

This prompt appears on the screen, and users can choose to practice in the outdoor setting. Or go to the practice area downstairs to practice.

Go down the stairs.

After exiting from this door, you can choose to go straight down the stairs or turn right to the balcony for sightseeing.

This indicates that the area is a mirror learning area, similar to dance, taekwondo, etc., and action learning requires mirror practice.

Walk forward to the mirror area.

You can see any user's own actions here.

The mirroring function can be turned off or on here.

This prompt indicates that you can start following the exercise.

Follow the practice. The frequency and duration of practice are entirely determined by the user themselves.

After the exercise, you can choose to study in the mirror area or practice in the outdoor setting.

Choose the course 'Toe edge' to learn about the toe edge (front edge).

The big screen starts playing the lesson.

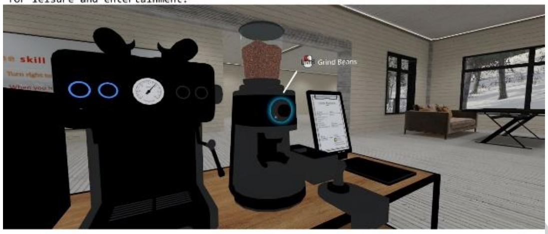
The appearance of "Imitation practice" on the screen means that the user needs to imitate and learn from the actions on the screen at this time.

At the end of the second floor corridor is the observation balcony.

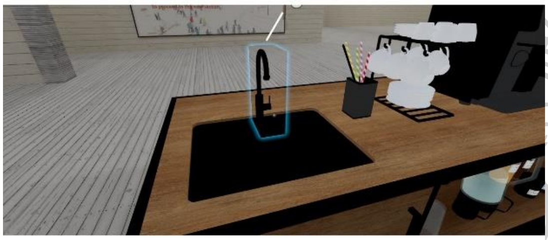
You can approach and open the door.

Appreciate the beautiful scenery of snow capped mountains.

There is a coffee salon on the first floor of the learning center, where users can come for leisure and entertainment.



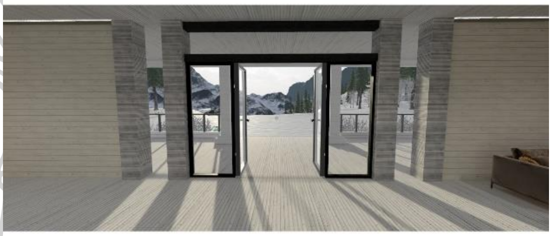
Users can use any prop in the coffee salon to mix coffee.



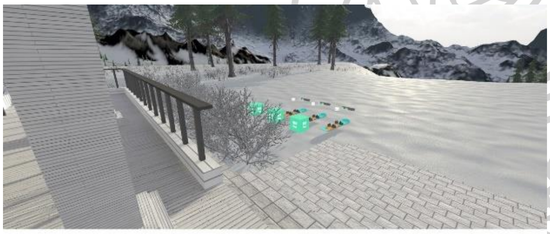
All props are available.

Turn left on the first floor to enter the rest area.

Go through the rest area.

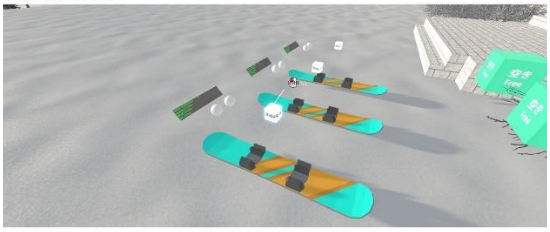


Open the door on the first floor and go to the snowboarding area.

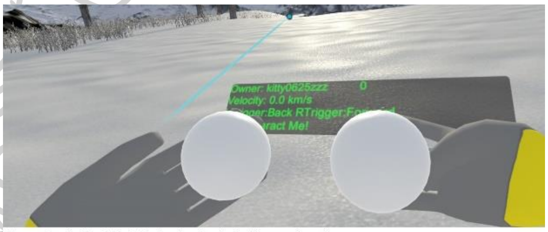


After leaving the learning center, turn left to see the snowboarding.

The green cube displays' Free ', indicating that the skis are currently unoccupied. Users can use it.



Select 'Ride' to use the snowboard.



Grasp the ball with both hands. Control the snowboard.

Practice manipulating the snowboard, like sliding down a snowy slope.

The snow slopes are rugged and uneven, and users can only control them perfectly after mastering the skills. But users don't need to worry about falling and getting injured.

Follow the stairs outside the learning center up the stairs.

Keep walking forward and you will see the snow go kart.

There are two snow karts here. Users can invite friends to start browsing the vast virtual world together.

Select a white cube. You can sit on the go kart.

You can control the amplitude of your left and right hands to start the go kart.

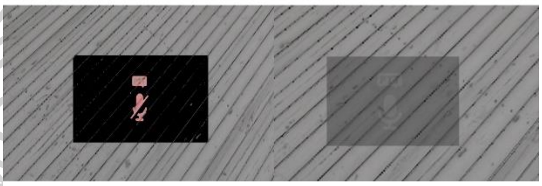
Select the pink cube to get off the car.

Walk to the left of the learning center to reach the location where you can take the cable car.

Go below the cable car and wait for it.

Once the cable car arrives, you can click to take it. Or when sliding down the mountain, you can click to take the cable car and return to the mountain.

Other Operations



You can choose to turn on or off voice through the controller. The voice function is used to facilitate real-time conversations among players.

Players can choose to take actions through the menu keys on the controller. This feature is built-in to the platform.

Players can select emoticons through the menu keys on the controller. This feature is built-in to the platform.

VITA

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